PUBLIC WORKS

Devoted to the interests of the engineers and technical officials of the cities, counties and states

MAY, 1939

A. PRESCOTT FOLWELL, Editor — VOL. 70. NO. 5 — W. A. HARDENBERGH, Asso. Editor

Contents

TIMEWASTERS

A serious rush of work to our desk has interfered materially with our usually leisurely contemplation of the no-account problems of the world, such for instance, as how fast a pail of water must be whirled around one's head; how far a book-worm must eat in order to come out on the farther side of a given number of text-books; and similar problems of world importance. But no alibis; not even answers to last month's problems. We shall merely set down in larger type than usual—for the benefit of those tired eyes that have been conning this section—a few minor problems to carry through the spring months.

Try This on Your WPA:

It is found that the quantity of work done by a man in an hour varies directly with his pay per hour and inversely as the square root of the number of hours that he works per day. He can finish a piece of work in six days when working 9 hours a day at 25 cents an hour. How long will it take him to finish the same piece of work when working 16 hours a day at 37½ cents an hour? *Contributed by Mr. Bevan.*

Two Questions from Mr. Blunk:

1. At what rate of speed in miles per hour must an automobile be traveling on a level road to enable it to jump a chasm 20 feet wide, with a fall of only 4 inches while passing over it? 2. Who would want to ride under such conditions.

A Brick and a Dornick:

If a brick weighs three pounds and a half a brick, what is the weight of a brick and a half? *Stephen Derry, Cleveland Engrg. Soc.* W. A. H.

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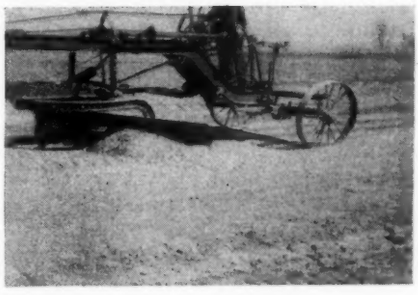


Adding Shipped-in Stone to Local Gravel

By C. O. Brownlee
County Superintendent of Highways, Shelby Co., Illinois

COST of materials is an important item in constructing farm-to-market roads. Rigid specifications calling for a standard gradation have generally resulted in high cost and defeated the purpose of this type of road construction, and recent tendency is to utilize as much as possible of the materials available near at hand, making up its deficiencies with material shipped in from outside.

For some time Shelby county has used the following loose specification for traffic-bound gravel or crushed stone surfacing material:

Passing ¾" sieve	100%
Passing ½" sieve	60% to 85%
Passing No. 4 sieve	30% to 50%
Passing No. 16 sieve	15% to 30%
Clay content not to exceed	10%

From experience, the maximum size of ¾" has proven most sastifactory, especially from the maintenance standpoint. Twenty-two cubic yards per 100 foot station is placed on the subgrade and spread, using the feather-edge method. To many this will seem to be an insufficient thickness; however, with good drainage it has proven to be satisfactory for 75% of the length of the average project. If the other 25% requires a greater thickness, it may be added by maintenance forces as the need becomes apparent.

In the southwest part of Shelby County there are several good gravel deposits (glacial) which will meet this specification with a small amount of processing, it being necessary to remove only a small amount of oversize materials and some fines. The top soil is a red clay having excellent binding qualities. This provides a good surfacing material at a low cost, and although placed under the traffic-bound classification, it results in a nearly stabilized road surface without the additional cost.

In the east part of the county, however, the local deposits run more to the sand gradation, and the alternative of utilizing these deposits or bringing in other material with a long haul had to be considered. A series of screen analyses were made to determine the mean gradation of a deposit that was located approximately in the middle of the first section to be built in that locality and off to one side about two miles. From 24 tests it was found that the deposit ran fairly uniform, but 78% of the material passed the No. 4 sieve while the specifications allowed only up to 50%. Therefore it was quite evident that, to meet the specifications, there would have to be considerable material added between the limits of ¾" and the No. 4 screen, and it was decided to try crushed stone for this.

C. O. Brownlee

Crushed stone weighs less per cubic yard than sand, so the volume of stone had to be proportionally more to offset this difference. Taking these factors in consideration, the most practical method of arriving at the proportion of crushed stone that would have to be added to make up the deficiency, was the cut and try method. Two volume boxes 12"x12"x12" were made. One was filled with local material, the other with crushed stone (graded between the limits of ¾" and ¼"), struck off and then mixed together and a screen analysis made of the mixed material. It was found that this proportioning would produce a resultant material that fell within the desired specifications yet was as lenient on the contractor as possible. Before making the screen analysis, the mixed material was placed back in the volume boxes to measure the loss in volume due to mixing. This was necessary, as the basis of payment was per cubic yard of the finished material measured in the truck beds. Subsequent tests

No local gravel could be found that would meet even lenient specifications for trafficbound surfaces; but instead of shipping in all the needed material, a mixture of half local and half shipped-in material was used, with satisfactory results.

Mixing and spreading combined materials

A finished stretch of road

were made during the placing of the material and bore out the assumptions.

The material from the local pit was loaded with a drag line (mixing about one foot of top soil with 8 feet of sand) and placed on the subgrade and windrowed; then the crushed stone was placed on the subgrade and the two mixed and spread with tractor and grader. Placing the surfacing began at the end nearest the source of material, so that the hauling was done over the new surfacing, thus binding in all the material nearly as soon as it was placed.

This has resulted in a stabilized surface requiring a minimum of maintenance at a cost of $1.75 per cubic yard for one section and $1.90 for the other.

Crushed stone used in this manner provides a mechanical bond not obtained in a 100% gravel surfacing. Samples taken from the compacted surface after a year's time indicate the possibility that there may be a chemical reaction that takes place also from the lime dust off the limestone. The material adheres together not unlike concrete.

The results have been such that I believe local deposits of gravel should not be processed beyond the removal of oversize material, and any deficiencies in coarse aggregate made up with the addition of crushed stone. I do not believe this will greatly increase the cost of surfacing if the expense of using extensive processing machinery and the wasting of excess fines are taken into consideration.

How Sudbury Exterminated Rats in Its Refuse Dump

SUDBURY, Ontario, last summer faced a rat problem. Rats were being run over by automobiles in the streets. An exterminator, employed by the Aldermen, found the seat of the trouble where it so often is—the city dump, which was piled high with auto bodies and trash of every description. To locate the rat burrows, the dump was burned over, using 3,000 gallons of used crank-case oil. The exterminator reported his findings and operations as follows:

"The colonies of burrows extended in some cases 400 yards from the actual foot of the dump in brush and over rock ridges where the rats had burrows in sandy soil on the ridges. The colonies of burrows had to be located, flagged, and treated individually first. By colonies we mean that so many rats would select a certain area in which to burrow,—in some cases we had 40 flags in a colony, each flag marking a mound of borrows used by 3 or 4 families for breeding; one mound would have perhaps 12 holes, but only 3 at a time would connect one with the other; so it was necessary to leave all holes open until there was evidence of dust coming from one or more holes.

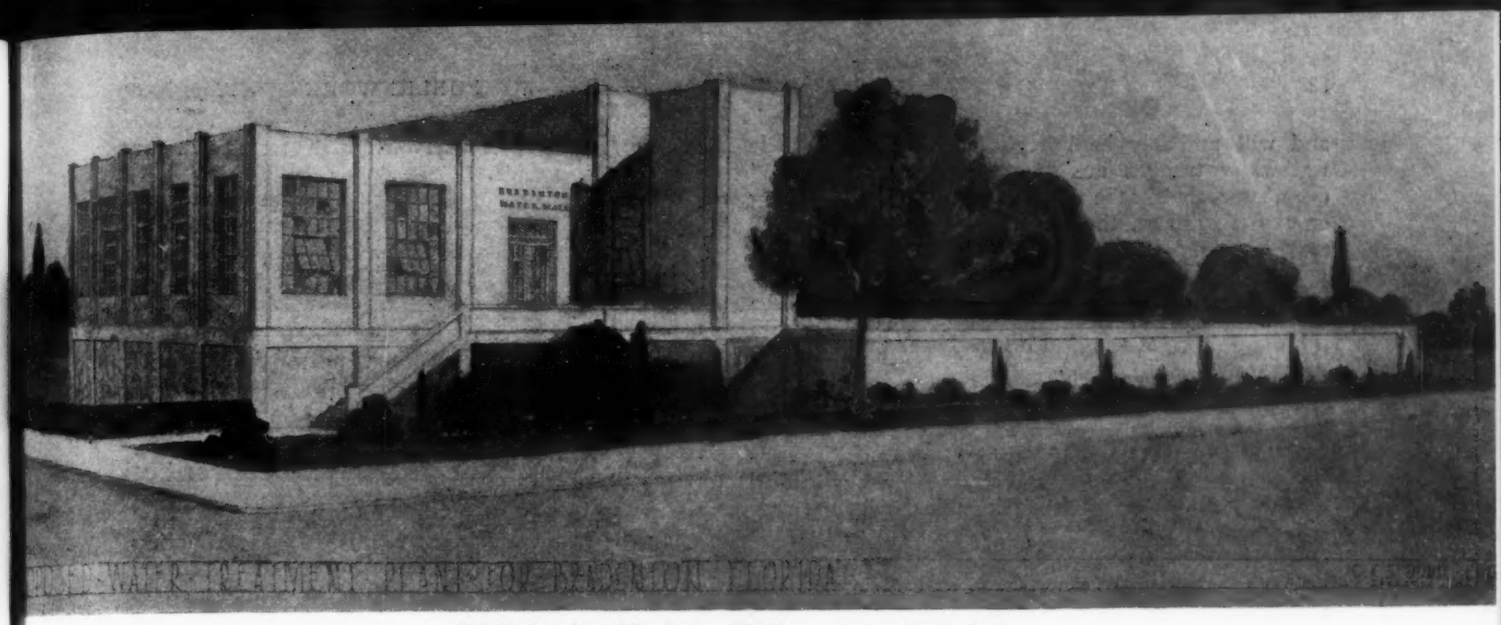
"In the treating of these burrows, we used chloropicrin and Cyanogas, but attributed not only our kill, but also the obvious repugnance the rats showed of returning to the burrows, to the Cyanogas A-Dust. We encountered little difficulty till reaching the foot of the dump, as the pumps were most efficient for this work. From then on encountering a nearly perpendicular slope, one hundred and twenty-five feet high, infested with burrows and covered with debris of all kinds, including automobiles, the foot pumps became futile. This necessitated an altogether new method of attack. We for days lined the foot of the dump with a 12-foot circle of gas, burnt off the head of the dump and drew the rats to the top in seething hordes.

"We discarded the use of chloropicrin, as the rats were obviously not getting enough of this gas to sicken them even in two or three days time, and because of the discomfort of working with it. We then tried carbon tetrachloride—carbon disulphide mixture, and found the weight of this gas to be most effective, instantly drawing the rats from the burrows under the debris; but again they did not suffer any serious effects from this gas owing to their quick passage into the fresh air.

"We realized the killing power was in the Cyanogas A-Dust, so we tried our final method—buckets were used to broadcast the dust from the slope, immediately followed by buckets of carbon tetra-chloride—carbon disulphide mixture. This drew the rats from the burrows, where they died instantly, when coming out into the Cyanogas A-Dust. This was our final solution and gave us wholesale extermination. We cannot estimate the numbers we saw and heard dying under the automobiles."

The City Engineer, reporting on the results, said: "On inspection of the dump on Sunday, October 16th, I was able, in a period of one and one-half hours to locate one rat. I, therefore, have no hesitation in issuing this certificate that the work has been carried out and that the dump is now clear of all rats."

Greenwich, Conn., has rat trouble due to discontinuing use of its dump. Three months ago it installed an incinerator and stopped carrying garbage to the city dump. The rats, deprived of their regular food there, sought it elsewhere and have spread over the entire town. Some are reported to weigh 6 pounds. The local exterminator and town officials have sent an SOS to the U. S. Biological Survey.



Artist's drawing of Bradenton, Florida, water treatment plant

Surface Water Use and Purification in Florida

FLORIDA relies very largely upon wells for its water supplies. Well water is obtainable in abundance in all parts of the State; but unfortunately most of it is high in mineral matter, sulphur in many wells adding its unpleasant taste to the hardness and other objectionable features of mineral content. In spite of the fact that there are many thousand lakes in the State (one county alone has over a thousand) and numerous streams, less than ten percent of the water supplies use surface water.

The latest figures available show 242 public water supplies in the State, of which 222 are from wells, 9 from lakes, 4 from rivers, 4 from canals and 3 from springs. (Some use two sources of supply, but in such case the main supply is used in this classification.) The populations supplied from surface sources range from 100 to 100,151 (Tampa), totaling 223,500.

Of the well supplies, 169 are not treated, 8 are aerated only (releasing sulphur or other gases), 21 others receive no treatment except aeration and chlorination. The other 24 receive some additional treatment, the most complete being that of Miami, which is aerated, softened, coagulated, settled, recarbonated, filtered and chlorine-ammonia applied.

Of the surface supplies, all but one are filtered. One of the most complete treatments is that of Ft. Pierce—iron removal, aeration, ammoniation, coagulation (lime and alum), activated carbon, sedimentation, mechanical filtration, chlorination and prechlorination.

The first large city to use a surface supply was Tampa, and its treatment plant (designed by the late Nicholas S. Hill, Jr.) is still the most complete and probably the best operated of any in the State. Water is obtained from the Hillsboro River, which varies greatly and rapidly in color and hardness. The water is coagulated, softened, settled, recarbonated, filtered and chlorinated; ammonia and sulphur dioxide also are used. This plant is in charge of J. E. Lyles, who has been with it since its installation in 1926, for the past six years as engineer in charge, and to whom the city is indebted for the uniformly excellent water furnished it under unusually difficult conditions.

A plant for filtering river water is under construction in Bradenton, Fla. This has several interesting features, but is chiefly notable as indicating an increased interest in use of surface water in a state where 90 per cent of the public water supplies are from wells.

The latest to adopt the use of surface water in the State is Bradenton, whose plant is now under construction as a PWA project. This city of about 7,500 population has been obtaining its supply from two deep wells, which is aerated as it is pumped into an elevated concrete reservoir. The new supply is obtained from the Braden river, about five miles from the city, from which it is pumped to a filtration plant adjacent to the existing wells and reservoir. The river water has a hardness varying from 6 gpg to 0.6 gpg, and color from 10 to 200, as the seasons change from dry to rainy.

As Gulf water sets up the river with the tides, a dam is constructed just below the intake, made of steel sheet piling with an apron of large stones. Near this is a pump house containing two 1200 gpm turbine pumps, motor operated, with automatic control capable of adjustment for starting pressures from 0 to 50 lb. and for stop pressures from 30 to 100 lb. An intake channel is dug from river to pumping station and filled with 2″ to 6″ rock to act as a trash screen. The water is pumped from the river to the treatment plant through 33,300 ft. of 16″ cast-iron pipe.

The treatment plant consists of four settling basins, each 25 ft. wide by 60 ft. long and 11 ft. total depth with 12″ freeboard and divided into two channels by a round-the-end baffle wall; two mixing basins, each supplied with two circulators; four filters; a clear well under the filters, and an aerator. Each filter is 12 x 15 ft., provided with Wagner underdrains, covered with 14″ of gravel from 1½″ to 0.8 mm in size, on which is 27″ of sand of 0.40 mm effective size and uniformity coefficient between 1.7 and 2.0. (Sand to meet the specifications can not be obtained in Florida,

and will probably be brought from Georgia.) The washwater troughs are of reinforced concrete, 15″ deep, supported in the middle by a 3″ c.i. pipe resting on the filter floor, the top edges ground to a level, smooth edge.

The inside walls of the filter boxes, from 1 ft. below the filter sand to the top, and all wash troughs, are to be given two coats of concrete anti-corrosive paint with synthetic resinous base and glossy finish, similar to Inertol "Romuck enamel."

There will be an operating stand for each filter arranged for hydraulic control of 5 valves, and "loss of head" and effluent "rate of flow" indicating and recording gauges. There also will be a liquid level indicating gauge showing clear well height; a float switch to ring a gong when water level in settling basins reaches the overflow level; a gong operated by a sensitive limit switch when depth of water in clear well is one foot, and another that rings when water ceases to flow into the aerators.

There are two aerators, each 1250 gpm capacity, in the aerator basin. Chlorine will be fed through 2 W & T semi-automatically controlled, solution feed, visible vacuum type feeders; ammonia feeder also is W & T, closing simultaneously with the chlorine feeder. There are also 6 dry feeders, 2 for alum, 2 for lime and 2 for activated carbon, with capacities of 2 to 8 lb. per hr. of alum or lime and 8 oz. to 20 lb. of carbon.

The plant building contains an office and laboratory, the floors of which are covered with asphalt tile, and sink, wall cases, stands, racks, etc. are provided; also a complete equipment of glassware, balance, autoclave, sterilizer, comparator, etc. The floor of the filter operating room is covered with asphaltic floor tile.

Two new low-lift centrifugal pumps and two high-lift centrifugals are to replace the existing pumps, using the old motors; the former with a capacity of 1300 gpm against a 40 ft. head; the latter with capacities of 650 and 1250 gpm, respectively, against a total head of 150 ft. These are to lift the purified water into the existing concrete reservoir, and from this into the distribution system.

The total cost of these improvements will be about $269,000.

The engineer of this project is C. K. S. Dodd, of Sarasota, Fla. Prof. A. P. Black served as consulting chemist. G. D. Armstrong is Commissioner of Public Works, C. W. Ward is Mayor.

Waterworks Items from Illinois

At Johnston City the superintendent and operator were away from the treatment plant for a short time one day last winter and on returning found in the laboratory a bill of lading indicating that some coal that had been ordered had been delivered during their absence. However, a glance at the coal bin showed it still empty. Further investigation located the coal in the clear well —proving that all manhole covers look alike to a coal dealer. Superintendent Gustat says, "The moral is, if you must feed carbon, be sure you know the correct point of application."

At Centralia, Superintendent Wallis has oil boom troubles aplenty. Oil wells are being put down all over the watershed of the reservoir which requires on his part constant vigilance to prevent pollution. But on top of all that, the reservoir itself has been found to be located directly over the heart of the very rich oil area. Believe it or not, all the land has been leased, even the reservoir, to a big oil company and they want to start drilling "through the reservoir." Plans for a new reservoir are being made.

W. F. Wiseman of Chandlerville sure has a novel idea for the final disposing of the lime sludge from his plant. When the wind is in the right direction a stick of dynamite is placed in the bed—boom—and away the lime goes all over the farm adjoining the plant. This method saves removing, hauling and spreading.

The above are from "Over the Spillway," publication of the Illinois Division of Sanitary Engineering.

Effect of Grounding Electrical Current on Pipes

As the result of questions raised in the American Standards Ass'n on the effect of electrical current flowing through water, gas or drainage pipe used for grounding, the American Research Committee on Grounding was organized and is operating under the joint auspices of the American Water Works Ass'n and the Edison Electric Institute. A technical subcommittee has been carrying on field investigations and reports the following conclusions therefrom.

There is no evidence that the current may not have contributed to the cause of the trouble in some cases, the technical committee reported, but in none of the cases investigated so far has the trouble been found actually due to alternating current on the water-piping system. On the other hand, it was found that important causes of the troubles reported included the tendency of the water to corrode the piping or other metal, the effect of dissimilar metals in the piping system creating galvanic couples, and corrosion of hot-water supply boilers due to abnormally high temperatures.

Six recent field investigations and several sets of laboratory tests were reported on by the technical committee. In one of the six cases investigated no trouble was reported—the investigation having been made because, in the construction of a large building, the electrical isolation of all protective grounds from the piping systems had been attempted. Electrical tests and inspection showed, however, that such isolation had not been attained.

In the second case reported, the complaint was of leaky water-pipe joints, and the trouble was apparently due to a combination of high water pressure and poor workmanship in the original installation.

In another case where the complaint was of a failure of boiler tubes, steady readings of small direct current were obtained at the boiler, indicating galvanic action. On the pipes and grounding conductor close to the service entrance the readings were small and fluctuating, indicating stray electric-railway currents.

In the three remaining cases the complaints were of discoloration or other impairment of the quality of the water delivered through taps on customers' premises. Of these three cases, one showed no electric current present on the pipes, another was cleared up by lime treatment of the water, and the third was remedied by reducing the temperature of the hot water to 140 deg.

Additional field investigations are to be made as cases are reported to the committee by water companies where troubles such as corrosion, impairment of water, sparking, or electrical shock are suspected as being caused by electrical grounding.

Field work is being supplemented by laboratory investigations of the fundamental electro-chemical principles involved. It is believed that these will throw considerable light on the causes of the difficulties.

Constructing Cannon Hill sewer in front of City Library

WPA Makes and Lays Five Miles of Concrete Sewer at Spokane

Spokane, Wash., is employing 1200 to 1500 men, through WPA, in making and laying five miles of concrete pipe sewer in sizes up to 60-inch, aiming to complete the work in a year's time.

SPOKANE, Wash., is constructing five miles of concrete sewer, ranging from 60-inch to 21-inch diameter, as a WPA project, to serve some newly built-up districts and as a relief sewer to some of the older districts whose sewers have long been inadequate. It will carry both storm and sanitary sewage and is known as the "new Cannon Hill sewer." At present it is giving employment to 1200 men, and the number may reach 1500. Plans call for its completion in about a year. The labor payrolls, estimated at $482,445, are taken care of by the WPA contribution, while the city furnishes material and equipment, estimated to cost $674,878.

Nearly all of the raw materials necessary, except steel, are produced in plants in the city, and this somewhat reduces cost and give employment to men in these plants as well as those employed directly on the sewer construction.

To avoid interference with existing pipes, utilities and viaducts, part of this sewer is laid at considerable depth. Much of it will be laid through solid rock, of which some 25,000 cu. yd. will be excavated. This rock is very hard and causes rapid deterioration of drills, 6 to 8 inches of drilling dulling a bit beyond use in some of the rock. After four or five sharpenings the bits are discarded. A grinder has been installed at the city yards and the city has provided some 2500 bits for the work. The earth excavation will total about 46,000 cu. yds.

Concrete pipe for Cannon Hill sewer built by WPA crews

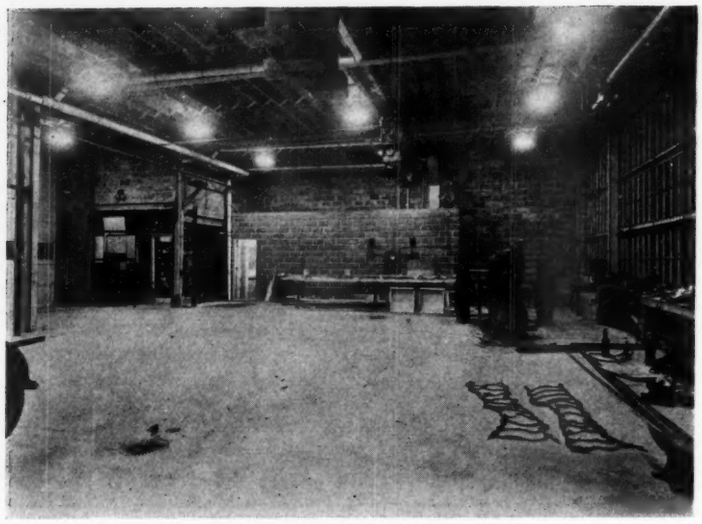
The materials to be used include, besides the 26,397 ft. of sewer pipe, 270,000 brick, 576,000 ft. of timber (2 x 6 and 4 x 12), and 50,000 lb. of powder.

Under the Northern Pacific viaduct, where the sewer is 21 ft. deep, 8 x 8 stringers and 3-in. sheathing is being used for bracing the trench, and will be left in place as added protection to the 60 in. pipe. This is the deepest cut, the greater part averaging 10 to 14 ft.

All of the concrete pipe for the job is being made in Spokane by the same pipe company that made the pipe for the Union Park, built a few years ago by the CWA. All sizes above 24-in. are reinforced. All of that above 36-in. is poured, while the smaller sizes can be machine moulded. The 60-in. pipe, which weighs 5,000 lb. per 4 ft. unit, is reinforced with steel mesh. All the precast pipe is open-air cured.

For lowering the 60-in. pipe to place under the Northern Pacific viaduct it was necessary, due to the restricted working space, to construct a special frame provided with a chain block.

City officials and engineers both agree that this work is proving ideal for WPA labor. Employment is provided for unskilled labor and also for skilled, such as drillers, timber men and those experienced in handling concrete pipe, all of which were available in the city; the work being done under the direction of experienced foremen. Inspectors are employed by both the city and the WPA, and the city engineer A. D. Butler and his assistants keep in close contact with the work. Every safety precaution is taken and so far has kept injuries on the job to a minimum. In deep cuts the dirt is removed by hand by several casts or terraces, but boulders and rock are lifted out in buckets.



Repair shop, with flat roof and glass side

Washington Designed

By FRANCIS L. BROWN
County Supt. of Highways of Washington County

IN 1938 Washington County, New York, built a new building for its Highway Department on the site of the old Washington County Fairgrounds, forty acres in extent, which the county purchased from the fairgrounds association, which had not held a fair for the past five years. The plot of ground is enclosed with a cyclone fence and fronts on U. S. Route No. 4 between Fort Edward and Hudson Falls. Along the rear frontage is the railroad of the Delaware and Hudson Company. A spur from this line into the grounds furnishes the site with access, both by highway and railroad, to transportation facilities.

All the money involved in the purchase of the land and the construction of the new building was deposited, in accordance with Section 126 of the Highway Law, in the County Road Machinery Fund, and spent on the order of the County Superintendent of Highways. Work was begun in May, 1938, as a tentative foundation plan had already been drawn and it was decided to speed the construction by placing a county bridge crew in charge of the foundations, thereby giving us time to work out the details of the contract work while the foundations were under way.

As a general consideration, the building was laid out in such a position that it would correspond with a master plan drawn up with the possibility of creating a whole county center upon the plot purchased, at some future date.

The basis of the design of the building itself was the actual garage, machine shop and office space required by the department in its present state of development. An architect was retained to work out the building details and to aid in securing a general architectural effect that would be in keeping with any future development.

The first consideration was to be able to store all our machinery in a space that would be protected in the winter time and have heat above a freezing temperature. Machines stored against the wall would need very little clearance, but considerable clearance was required in manipulating machinery into position and traveling up and down the main aisle of the proposed building. The usual forms of construction—the bowstring arch, the usual roof truss, and also the beam and column method of construction—were investigated, but none of these seemed to fit the requirements that we had in mind. The newly developed rigid frame seemed to be the answer to our problem, and the decision to use this rigid frame to support the roof of the garage was perhaps the primary motive in the design of the building itself. Having decided to use this type of construction, the eaves height was determined by the clearance necessary for the cab of the shovel, our largest piece of machinery, and the slopes of the roof were determined by the clearance needed by the boom when placed in normal position when the shovel was backed against the wall. This is demonstrated in the photograph of the garage space.

The second consideration was the machine shop, which required a constant elevation of the roof, inasmuch as it was desirable to move any piece of machinery to any position of the shop, as might be dictated by the repairs that were necessary. Therefore, a constant height roof was adopted. For this the column and beam method of construction is the most satisfactory, and it was decided that the beams carrying the roof should be designed to also carry crane loads, so that heavy pieces of machinery or parts of machines might be conveniently lifted in any point in the shop space.

The third consideration was the office space. It was desirable to have this office space all on one floor and

Garage or storage section of building

County Creates a Carefully Highway Department Center

In designing its new building, the highway department engineers of Washington County studied carefully the requirements of garage, machine shop and office; adapting area, roof heights, construction and lighting, floors, etc. of each to its own requirements which differed materially, each from the others.

Francis L. Brown

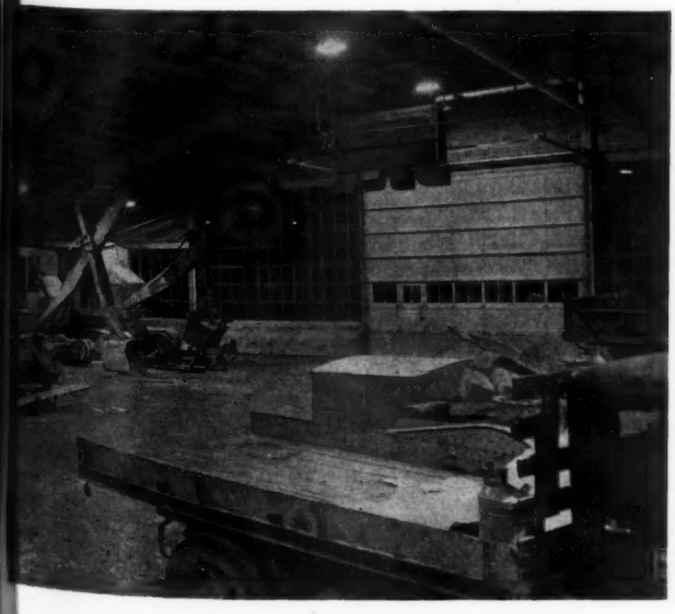
have the different offices inter-connected in such a manner that access between one function of the department and another was easy. Therefore, a single-story construction was decided for the office space.

Taking these three considerations together, we had three different roof requirements and the outside of the building was designed to combine these three different requirements into a single unit that was architecturally pleasing.

Garage Details

The actual details involved the best use of the materials available. In the garage, it was decided to furnish all the light from one end, which could not easily be obstructed. The use of windows along the side walls was eliminated because machinery stored along these walls would obstruct any light from them. The use of plain wall construction eliminated any sash and reduced the cost of the building.

As a floor material, a pre-mixed bituminous pavement was used over a six-inch stone sub-base. The use of this material was dictated by the fact that the movement of heavy machinery might cause a cracking and spalling of the concrete, unless the construction was extra heavy. Instead of the expensive concrete construction, bituminous pavement was used, being not only cheaper to construct, but also easier to patch. To date the pavement has amply demonstrated our premise.



Machine Shop

In the machine shop it was necessary to furnish a very substantial, smooth - surfaced floor; therefore, a heavy 8-inch reinforced concrete floor was used. Good light was furnished by placing sash clear across one end of the building. This has proved a definite aid to our repair work and also in the source of considerable heat on a sunshiny winter's day. It is not expected that the summer sun will bother to a great extent, as the position of the building is such that the sun will be overhead most of the time during the summer months, and we will have very little direct sunshine into the machine shop proper. Also, ample ventilation is provided.

All the doors are overhead doors having 16′ horizontal and 15′ vertical clearance, which does not infringe upon the free movement of any machine. To enable test runs of machinery in the shop, exhaust machines for exhausting fumes through the roof are provided.

The offices are so grouped as to provide easy access from the superintendent's office to the outside general office, the stock room, and the drafting room, in which are located all sections of work under way and under his control. The offices all have inlaid linoleum floors, but no attempt is made to use expensive wall construction. Doors and sash finishes are in natural wood, and cinder concrete block was used as a structural material whenever possible.

Following the completion of the foundations by the bridge crew, contracts were awarded for steel, general, heating and ventilating, and electrical work. The contract work began about the first of August and was completed about the middle of December. Actual possession of the building was taken about December 22nd, when the offices of the superintendent and his staff were moved into the building.

The steel frame, which is welded throughout, was contracted for by the Austin Company of Cleveland. Their bid for furnishing and erecting the steel with welded construction provided that the county furnish the electric welding machine, by doing which we not only got a lower bid, but we have a portable machine for our own use now. The type of construction adopted, namely, the welded steel frame, the concrete foundations and water table, cinder-concrete walls, and timber roof construction, have proved satisfactory to the present time.

Roofing material on the pitched roof section was slate, which is a native product of Washington County. The flat roof sections are twenty-year guaranteed Johns Manville built-up roof.

The heating system furnishes warm air to maintain a temperature of 50° in the garage by the use of two large unit heaters placed close to the ceiling; and 70° in the machine shop, by the use of two other unit heaters. Office heat is supplied by cast iron steam radiators. The heating system is low-pressure steam, using the finer grades of hard coal, which were found to be the most economical for our operation. Heating in the machine shop and the garage is controlled automatically by thermostats.

Using this structure, which is approximately 150x90 feet, are the superintendent, his clerical staff, an engineering force of eight men, and a machine shop crew which is maintained at about six or seven men.

In the winter time, all machinery is kept in the storehouse, with the exception of snow plows, which are placed at convenient points for immediate operation in case of storm.

The location of the building is about halfway between the north and the south end of the county (which has a total length of seventy miles), and at the west end of the county (which has a total width of twenty-five miles), near the metropolitan area of Glens Falls, making servicing of the machinery much easier than at any other location. Therefore, it is as centrally located as possibly could be obtained.

The total cost of the building was $38,000, exclusive of the lands and fence; making an average construction cost of approximately 18 cents a cubic foot.

General office, showing aerial map of county on rear wall

Three Years' Results in BOD Reduction With Chemical Coagulation

ALUMINUM sulphate has been used for coagulation at the Liberty, N. Y., sewage treatment plant since 1935. The plant was described in this magazine in October, 1935, and results of treatment were given in the issues of January, 1936, and July, 1937. Herewith are given the results in BOD reduction for the past three summers.

The summer sewage is very strong, also the volume of flow is greater than in the winter. Summer flow has averaged about 900,000 gpd; winter flow about 500,000 gpd. The BOD of summer raw sewage runs from 350 to 400 ppm; in winter, the raw sewage has a BOD of 250 to 300.

Coagulation results in greatly increased sludge production. During a part of the summer of 1937, and most of the summer of 1938, it was not possible to dry sludge rapidly enough to prevent discharge of sludge through the supernatant overflow to the inlet of the settling tanks, resulting in a heavy load on the tanks. Under these conditions, coagulation was not so effective and BOD reduction was greatly reduced. Also, the summer of 1938 was a very wet one, and flows were considerably higher, resulting in a lower BOD of the raw sewage.

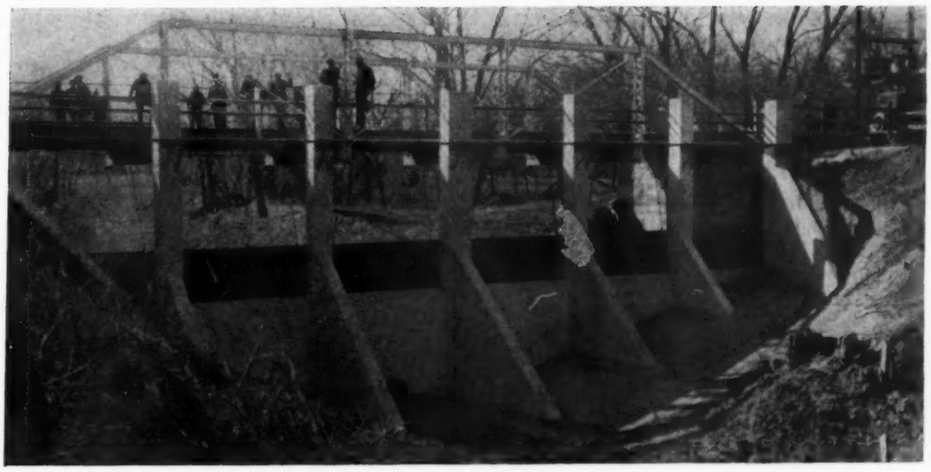
Month	*No. of Tests*	*Average BOD, Raw*	*Average BOD, Effluent*	*% BOD Reduction*
		Results in 1938		
June	4	275	68	75.3
July	5	350	118	66.3
August	4	330	118	64.2
		Results in 1937		
July	2	325	138	59.0
August	9	442	96	78.3
September	4	650	94	87.0
		Results in 1936		
August	7	401	77	80.0
September	15	448	74	83.5

Results according to the day of the week are shown in the accompanying table. The heaviest loads appear to fall on Tuesday and Saturday, which is believed to be caused by peak load discharges from the local laundries.

Day	*Number of Samples*	*Average BOD, Raw*	*Average BOD, Effluent*
Monday	9	378	93
Tuesday	14	454	97
Wednesday	7	376	90
Thursday	11	337	104
Friday	7	363	87
Saturday	4	594	108

BOD determinations are not normally made during the winter months when the plant is operated as a plain sedimentation plant. The summer season begins about June 15, and chemical treatment is started at that time. The summer season ends about September 15, but the load continues for some time thereafter due to necessary work in connection with closing the summer establishments, including a very heavy laundry load. Chemical treatment is discontinued approximately October 1, unless weather conditions cause very low water in the diluting stream.

It is believed that a BOD reduction in excess of 75% can normally be maintained at this plant, despite the strength of the sewage. Steps are now being taken to provide for the disposal of the excess sludge and thus relieve the load on the sedimentation tanks.



Down-stream side of Dannebrog lake dam. Highway bridge just behind it.

Designing and Building Dannebrog Lake Dam

By L. R. RUDD
County Engineer, Hall County, Nebraska

A small dam but with some interesting features—made of reinforced concrete supported by steel sheetpiling; much of the work done from a highway bridge a few feet up stream from the dam; all concreting in freezing weather.

DANNEBROG LAKE DAM is located on Oak Creek, in the village of Dannebrog, Howard County, Nebraska, a village of about 400 population. The project was originally conceived by the Village Board as a WPA project and the writer was called in as designer and consultant. After preliminary surveys were made, it was necessary to petition the State Department of Roads & Irrigation for permission to dam and store the waters of Oak Creek; and for approval of the plans for the structure. Then the project was worked up as a proposal to WPA authorities, who finally approved it for recreational and park purposes, since no power or irrigation benefits were contemplated. The dam impounds the flow from a drainage area of about 225 sq. miles of agricultural, pasture and timber lands. The normal run off is fairly slow, but the stream carries considerable silt and debris during high water stages.

At the site selected, which is only a few feet down-stream from a steel truss highway bridge, the stream channel is about 80 feet wide, and 18 feet deep, with 50% bank slopes, and 5% approaching slopes. Test borings showed clay and loam top soil in stream banks, underlaid with blue muck above sand, and with a "hard pan" base about 10 to 12 feet below stream bed. Earlier experiences with a rock, earth and timber dam in the near vicinity provided much valuable data for planning size, height and features of the proposed structure. The dam was designed for an 18-ft. head against an effective base of 14 ft.

The structure, as designed, consists of a 12″ reinforced concrete wall, 90 ft. long, extending well into firm banks, and about 5 ft. below stream bed. This is supported by a steel sheetpiling cut-off wall, embedded 7 ft. in the concrete wall, and driven well into the hard pan; and further supported by seven 8″ H steel piling, which piling also extend above the concrete wall. These projections are encased in concrete, forming a 6 panel weir, and serve as supports for adjustable timber stop logs or sliding gates. A 6″ reinforced concrete floor and apron is provided downstream; and five reinforced concrete buttresses and two wing retaining walls provide further reaction against overturning. Creosoted yellow pine piling support the floor and buttresses.

The crest of the panel weir formed by the concrete wall and posts is 9 ft. above stream bed and the stop logs or gates, when closed, provide 4 ft. more depth. A 24″ pipe with a "one way" gate is installed at floor grade to provide means for flushing silt or draining the reservoir. A foot walk is installed on steel brackets, attached to the concrete encased panel posts. The six stop logs or sliding gates are 4′ high by 10′ long, built of cleated 4″x12″ treated planks, with batts over joints. These gates slide in Z bar guides attached on the up-stream face of the concrete posts. They are regulated by means of chains wound upon iron pipe shafts above, which are hand operated by ratchet "wind up" devices at each end of the dam. Minor seepages around the gates were practically eliminated with canvas strips.

The original design was made to fit into a given length of stream bed, thereby forcing a rather short floor and apron. After construction was nearly completed, trenching operations for a water main (not a part of the project) caused a weakening of the clay seal at one end of the dam, and an early spring freshet broke through, around the structure. To insure against a repe-

tition, the concrete wall and sheet piling were extended 15 ft. at one end and 5 ft. at the other; mud and cement mixture was mud-pumped under the damaged end and floor; and permission was obtained from adjacent land owners to extend the floor 20 feet further downstream and to provide concrete faced slopes. Since completion, several floods have passed through the structure without damage thereto. During construction, a small spring from a lateral source was opened under the floor, and is now handled through a 4″ pipe set in the floor.

The dam was constructed by a private contractor, under contract by bid, who furnished all equipment, superintendence, and foremen, and about 75% of materiad. WPA furnished all labor, a sub-foreman and time keeper and about 25% of material. The original contract was started in January, 1938, and completed about April 1st. The additions mentioned heretofore were placed shortly thereafter.

The steel and treated timber piling were driven immediately after preliminary excavation while there was no flow in the channel. The stream then developed a nominal flow and the site was dammed with short timber sheet piling, and de-watered, and the flow was passed through a 15″ culvert pipe, above floor grade.

The concrete wall and apron wall were then formed and poured continuously, up to floor grade; the floor was then poured; the balance of the wall, the buttresses and the retaining wall wings next, and the posts were poured last, all connecting bolts and anchors for hoist arrangement being embedded in concrete. All concrete is 1:4 mix, the aggregate consisting of washed and graded Platte River gravel, which was trucked about 25 miles to the site. Since all pouring was done in freezing temperatures, all aggregate and water were heated, and canvas and burlap covers with salamanders were used over new concrete until forms were removed. All exposed concrete surfaces were "stone-rubbed" to a smooth finish. All construction joints were "tongued and grooved" by embedding 3″x6″ or 4″x6″ timbers at the top of each pour and later removing them before the next pour was started. The presence of the highway bridge eliminated much false work and it served as a very convenient foot walk and platform during construction. The village's power lines were tapped for illumination at night during continuous pours.

The lake or reservoir impounded varies from 0 to 13′ in depth and from 10′ to 70′ in width, and is 2½ miles long at stop log crest elevation. A park has been developed along the banks and the lake is used for boating, swimming, skating and fishing. The total cost of the dam was approximately $9,700, the village's share being practically 40%. The Diamond Engineering Company of Grand Island, Nebraska, were the contractors, and Fred Sorenson was Chairman of the Village Board of Dannebrog.

Electrical Thawing of Water Pipe

The accompanying letter from Louis M. Weld, president and manager of the Sand Spring Water Co. of Meyersdale, Pa., is a welcome contribution to our "Comment and Experience" pages.

Editor Public Works:

Dear Sir:

I was much interested in the letter from M. C. Bright in the January issue re, his experience in thawing copper pipe. I had three months daily practice thawing service lines during the winter of 1935-1936 and had no difficulty in thawing service lines and mains and did not damage either the service lines or the mains.

Due to the fact that we install all copper service lines, I had W. S. Darley & Co. of Chicago build me, in 1934, a small portable transformer that can be used on either 220 volt or 110 volt A.C. current, stepping it down to 10 or 20 volt secondary current, giving an inverse increase in amperage. I found this machine would thaw copper pipe up to 2″ and cast iron up to 8″. I mounted same on the front of my Ford coupe and carried my cables in the back, thus having very portable and easily handled equipment.

Mr. Bright speaks of his experiment with 60 ft. of 1″ type K copper tubing. Four hundred amperes should have thawed this tubing in 15 minutes had his cables been large enough. The heat generated in the pipe is caused by the resistance, and if his copper tubing offers less resistance than his cable, the cable will get hot instead of the pipe. In a neighboring town I was called in to thaw a copper line and thawed it out in 20 min., although several days before a more powerful transformer had been used for 12 hours, which not only heated up the cables but burned out the transformer on the electric power lines.

I know little about thawing water lines with a welding generator except that I noted that winter that in a great many cases when the current passed through cast iron mains, leaks developed that made it necessary to dig up the streets and recalk the lead joints.

As I stated before, I did not have a single line or main break or develop a leak, and as a result of my observations, I do not allow anyone to attach a generator so that current may go through our cast iron mains.

In reply to the inquiry from Mr. Bright, published in the January issue, Mr. Germann sends the additional information given below. The reference is to his article published in the December issue.

The transformers used in this hookup are standard distribution transformers, rated 2300/115/230 volts. Using the two 7½ KVA transformers alone, I connect direct to the 2300V line. By adding the 10 KVA transformer and reversing the connections, makes the thawer more flexible, as there were places where we did not have 2300V, but had 220V.

Another reason for using the hookup as shown in "Public Works" is less danger of making the connections with inexperienced help.

By using two 10 KVA transformers the Amps. can be increased to about 500.

I have used this manner of thawing pipes for several years and have had very good success. I have thawed iron, copper and lead service pipes and 4″ and 6″ cast iron mains.

Hoping that the above explanation answers your questions satisfactorily.

Yours truly,

J. E. Germann,
Auditor & Supt. of Water Works, Plankinton, S. D.

Rapid Road Maintenance Using Tandem Graders

Mitchell County, Georgia, maintains its 1600 miles of highway by means of two wheel tractors equipped with low-pressure pneumatic tires, each pulling an 8-foot grader and a 10-foot, in tandem fashion. This permits giving the entire road a careful working on one trip. All the main roads of the county are worked in this way at least once every six weeks.

The tractors used are Model I-40 International 6-cylinder, 58 hp., with four forward speeds.

Mitchell County's maintenance outfit

The Editor's Page

Laying Sewers in Water-Bearing Soils vs Sewage Treatment

It is surprising to note how few cities take any special precautions when laying sewers through water bearing soils, and also how very few test the sewer for tightness after it has been built. Of 78 cities in six states, selected at random, 11 use special pipe in wet areas—mostly cast iron, and 36 use some type of special joint. Only 19 of these 78 cities measure the amount of infiltration before covering the sewer.

Where a community is so fortunate as not to be forced to treat its sewage, a heavy flow of infiltered storm water during wet weather periods is not so important, though occasionally the lines become surcharged and manholes (and even basement plumbing fixtures) spout sewage to the tune of bitter complaints on the part of citizens. But when a high degree of treatment must be given to the sewage before discharge, happy-go-lucky methods of sewer construction are costly. Treatment units must be built far oversize, at a cost greatly in excess of that otherwise necessary; and operating troubles and operating costs mount in unison.

The use of better materials in doubtful areas, the enforcement of more rigid specifications in construction, and careful testing before acceptance of newly built sewers are needed; and with the present tendency toward more and better sewage treatment, these necessities will be emphasized. Good construction now will cost little more and will save many times that little in the future.

Engineering As It Was, Is and Will Be

Times are changing rapidly, and not the least change of post-war years has been in ideas concerning social relations, interrelations, rights and obligations. These changes affect "professional engineers" (this new designation itself indicates a change) not only as citizens but also as engineers.

There have been several definitions of an engineer suggested from time to time by members of the profession. The latest is one prepared by Dr. Karl T. Compton, President, Massachusetts Institute of Technology, with the help of members of the Committee of the E.C.P.D. on Engineering Schools. Their definition is as follows:

"An engineer is one who, through application of his knowledge of mathematics, the physical and biological sciences, and economics, and with aid, further, from results obtained through observation, experiences, scientific discovery, and invention, so utilizes the materials and directs the forces of nature that they are made to operate to the benefit of society. An engineer differs from the technologist in that he must concern himself with the organizational, economic, and managerial aspects of his work."

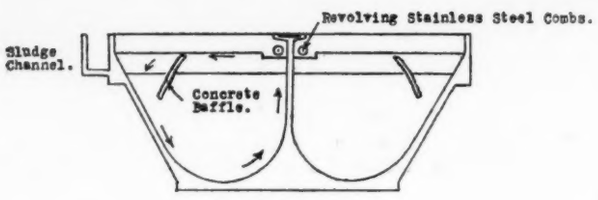
Note the comparatively novel ideas implied by the words "biological," "economic," "organizational" and "managerial." The man whose engineering knowledge is confined to mathematics, use of surveying instruments and the strength and other qualities of structural materials can not today advance far in the engineering profession. Biological knowledge is an additional requirement in only one branch of the profession; but economic, organizational and managerial aspects are of prime importance to those who would be leaders in any branch. Several of our leading engineering schools are recognizing this in their curriculums, but more are not; and few students or young graduates are sufficiently impressed with it.

Perhaps the most recent aspect to assume importance is that involved in the words "benefit of society." To "sell" an engineering project to financiers is often essential to the consummation of it, but to convince the people as a whole that it would benefit them is becoming even more so. Cities are no longer being planned with the sole view of yielding the greatest income to property owners; the elimination of old slum districts and prevention of new ones is becoming a major consideration. A bridge or elevated water tank is no longer designed to be merely adequate in capacity and strength —it must be aimed to satisfy the esthetic desires. Rubbish heaps are not approved, even though only the poorest live near them.

We wish to urge, on the young engineers especially, a serious consideration of these new aspects of their profession, and a realization that not only their personal advancement but also the standing of the profession in popular opinion will be promoted thereby.

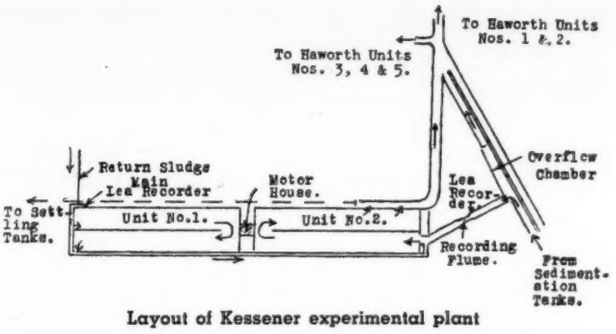
Copper Sulphate for Root Control in Sewers

Some time ago we were asked about the possibility of clearing roots and growths from sewers with copper sulphate. A recent questionnaire sent out by us indicates that it is fairly common practice to do this. We believe it will work, but we also believe that it is likely to be hard on the trees. Much will depend on the type of tree and on the season of the year. We passed the question on to a state agricultural college, who gave the opinion that copper sulphate would be quite likely to kill the trees. In those cases where it would be embarrassing to have a flock of highly prized trees (they seem to become much more valuable after they die) succumb, we believe that advice from your state agricultural college and perhaps a little private trial in a secluded spot would be a good thing. The real solution, however, to this problem is to make all sewers tight by the use of good pipe and good jointing material. In the long run it is cheaper to build properly first than to repair frequently later.



Typical Cross-section.

Cross-section of Kessener double tank



Layout of Kessener experimental plant

Kessener Brush Aeration at Stockport, England

An overloaded English bio-aeration plant was relieved, and its effluent improved 25 per cent, by reaerating the return sludge, using the Kessener brush aeration process. The operating power required for this is about one-third less than for aerating by the Haworth system.

A SEWAGE treatment plant using Haworth bio-areation units, operated in Stockport, England, since 1934, had become overloaded since the dry-weather flow had increased from the design capacity of 5.5 mgd to 6.25 mgd, so that aeration was inadequate. Instead of adding more tanks, Manager A. R. Ward considered increasing the aeration by reconditioning the return sludge; also giving the sewage some form of preliminary treatment.

A visit was made to Belgium and Holland to inspect the Kessener brush system in operation, and he was particularly impressed by the simplicity of the mechanism and the surprising results obtained by this system in treating difficult trade wastes, and the low power consumption. Accordingly, two units of this process were constructed at Stockport and brought into operation in October, 1937. Each unit was 127 ft. 3 in. long by 33 ft. 2 in. wide on top, separated into two parts by a central wall, the upper part of which stops short of one end so that the sewage, after aeration in one part, passes around the wall over a submerged weir and back through the other part. The tank is 12 ft. 3 in. deep at the lowest part of the curved bottom. The outer sides make an angle of 30° with the verticle. Near each outer side is a curved, partly submerged baffle wall to produce spiral flow. Cross beams 1 ft. 10 in. deep tie the walls of the tank together and serve to support both the curved baffles and the shaft bearings.

The aeration is effected by revolving brushes, each consisting of ten rows of combs of stainless steel fixed to the shafting, the overall diameter being 12⅞ in. The combs, stamped from 26 S.W.G. chromium nickel stainless steel, 440 brinell hardness, are calked with lead into grooves cut into the 3¼ in. mild steel shafting, which is revolved at 140 rpm by a 30 hp motor in tank No. 1 and 20 hp in tank No. 2. The two tanks are placed end to end with the motor house between them. Tank No. 1 was designed for reconditioning sludge, and No. 2 for partial treatment; but the latter was used also for aerating sedimentation tank sludge in parallel with the Haworth units in order to compare the two types.

In reconditioning return sludge, No. 1 proved admirable. When first put in operation, the activated sludge was in a foul condition, but by using both units for a time it was soon brought into good condition, in which it was then kept by No. 1 alone. Quantitative tests on oxygen taken up and its relation to the volatile solids are being continued; but 15 months' operation show these units to be very useful in improving the quality of the final effluent and their operation very economical.

During December 76,787,000 (British) gallons of sludge were treated through No. 1, giving an average of 2,477,000 gpd and the power used was but 9.15 kwh per million gallons a day—less than the power used to pump the sludge from the sump to the unit. The return sludge varied in total solids content from 4.5 to 10.0 grams per liter.

To test the completeness of mixing effected, salt was added to the incoming tank effluent, and samples taken at various points indicated complete mixing.

Operating No. 2 in parallel with the Haworth units, the results obtained varied only slightly and in both directions. The time of retention in the Kessener units was considerably less than in the Haworth, wherefore the temperature in winter remained higher in the former than in the latter, often 4° or 5°. The power consumption per million gallons per day was between 33.24% and 37.62% less by the Kessener in three runs of tests. (The amount treated averaged 1,076,000 gpd in the Haworth and 757,000 gpd in the Kessener.) The amount of reconditioning sludge used was the same for each—about 25% by volume after one hour's standing, reduced to 20% in the Fall test.

Figures for purification, given by percentage of oxygen absorbed averaged by months, based on the tank effluent, show percentages of 57.5 to 68.0 for the four months previous to October, when the Kessener tanks went into operation; and of 70.9 to 79.9 (average 76.0) for the twelve months of 1938. On the basis of the crude sewage the average for 1938 was 84.4%.

The tanks cost about $27,000; machinery $9,000; miscellaneous $10,000.

Designing Automatic Sewage Pumping Stations

Designing a sewage pumping station which is to work automatically consists not only of selecting the proper equipment but also of calculating the best size of rising main and size and shape of suction well. An excellent analysis of the method of making such calculations has been prepared by L. B. Escritt, an English engineer, and published in "The Surveyor," a leading English municipal engineering paper. We believe American engineers will be interested in this, and we give an abstract of it herewith. Readers will bear in mind that practically all sewers in England are on the combined system, and that it is standard practice there to carry six times the dry-weather flow to the treatment plant and discharge all in excess of this into the nearest stream.

IN designing small plants, precise designing is not necessary, since provision of large factors of safety is not expensive. But for large stations, excessive factors of safety should not be allowed.

Taking first the number of pumps. Assume a normal daily peak three times the average dry-weather flow, and allowance for passing six times such flow to the treatment plant; excess beyond this to be pumped to a stream through a separate rising main. For pumping to the treatment plant there may be 3 pumps, each capable of delivering 3 times the dry-weather flow, one pump to serve as a stand-by. More smaller pumps would be more costly to install and more liable to inefficient running, and only one pump (besides the stand-by) would be either of too small capacity for peak flows or objectionably large for normal ones.

The rising main should be large enough to carry the maximum pump discharges with velocities not in excess of 6 ft. per sec. (10 ft. at the outside) because of friction head created; on the other hand, the velocity should not fall below 3 ft. (2 ft. as an occasional limit) to prevent deposits in the pipe. Velocities somewhere in the region of 3 ft. per second are economical when there are long periods of pumping, but if the pumping periods are short a higher velocity is economical. If, with the pumps discharging the maximum of 6 times the dry weather flow, the velocity is 6 ft. per second, then the velocity at peak day flow would be 3 ft., and there would be no pumping at a lower rate, the pumps operating intermittently if the sewage fell below this. This suggests a disadvantage of a number of pumps; for if there were four, for example, one would have a capacity of ½ the normal peak flow, and either this, when operating alone, would give a non-cleansing velocity of 1½ ft. per second in the main, or the operation of all four would give more than 6 ft. with corresponding high friction head.

Designing the Suction Well

To illustrate by an actual case, assume a dry-weather flow of 600,000 gpd (720,000 U. S. gallons), or 66.6 cu. ft. per minute. Then each of three pumps would have a capacity of 200 cu. ft., or 3 times the dry-weather flow. Any sewage in excess of 400 c.f.m. would be bypassed to a stream or pumped by other pumps. In the suction well would be arranged floats operating automatic starting gear, or electrodes for that purpose. The arrangement of these and the proportions of the well require consideration. The well should not be larger than is necessary, both to effect economy of construction and minimize sedimentation therein. The capacity, however, must be so large that when the flow arriving at the plant is less than the delivery of one pump, or is more than the delivery of one but less than the delivery of two pumps, the pumps are not caused to start and stop at intervals so frequent as to injure the automatic starting mechanism. It has been quite common for designers to allow "rule of thumb" suction well capacities of, say, 15 or 20 minutes' normal rate of flow for this purpose. But the fact that ejectors of similar horsepowers require no suction well but are dependent on their period of filling and discharging, which period can often be less than one minute, shows that 15 or 20 minutes' flow is excessive. Starters are manufactured which will operate without overheating 40 times an hour, others which may operate only 15 times an hour. The former should always be specified, but where strict economy in the suction well is not necessary, a factor of safety may be obtained by assuming 15 starts per hour, which is adequate.

The most frequent starting and stopping of an automatic pump occurs when the rate of flow to the plant is one-half the delivery of the pump in question, or this plus the amount already being discharged by the other pump. In the hypothetical problem, if the flow into the station is at the rate of 100 cu. ft. per minute, and the well has a capacity of 100 cu. ft., the well will fill in one minute, after which the pump will start and pump out the sewage at the rate of 200 cu. ft. per minute; but as the flow is coming in at a rate of 100 cu. ft. per minute, the well is emptying at 100 cu. ft. per minute, and is therefore emptied in one minute. Thus, a complete cycle takes place in two minutes. To give starting intervals at the rate of fifteen per hour, one requires a complete cycle of four minutes, which in this case necessitates a well with a capacity of 200 cu. ft. *Thus we obtain the rule that the minimum size of suction well for fifteen starts per hour is one minute's pumping capacity of the largest individual pump installed.* By capacity in this case is meant, of course, only that capacity between the starting and stopping levels in the suction well of that particular pump.

In the earlier types of pumping stations it was usual to arrange the cut-in levels of the different pumps at 6 in. intervals vertically, and sometimes to have all pumps cutting out at the same level. If this method is applied to large stations with small suction wells, there is the possibility of a breakdown due to the fol-

lowing causes: suppose that the sewage commences to flow into the well at a rate equal to that of one pump, and fills the well until the first pump cuts in. Before the first pump has attained its maximum speed the water will have risen still higher in the well and if the second pump has not its cut-in level sufficiently high above that of the first pump, the second pump may start. The two pumps together will then empty the well rapidly and, particularly if both cut out together, will cause the well rapidly to fill and empty. Such an occurrence might happen also with three pumps, in which case the rate of starting and stopping will be very high.

Before the cut-in levels of the pumps are determined, it is necessary to find the required horse-power, as the normal starting times of the automatic starters are long in high horse-power installations. Where, however, horse-powers not exceeding 500 b.h.p. are to be installed, it is safe to say that the time required for a pump to attain maximum speed is not likely to exceed one minute, while half a minute should be sufficient for horse-powers up to 150 b.h.p.

In order that the storm water overflow weir shall not come into operation until the capacity of the dry-weather flow pumps has been exceeded, the cut-in levels of the last pump must be below the weir a sufficient distance for the capacity of the well between that level and the weir to be, say, one minute's discharge of the last pump, or more correctly, not less than the quantity that that pump, when running full, would discharge in the time required for the pump to start. The interval between the cut-in level of this pump and the cut-in level of the one before it would similarly be dependent on the starting time of the former to cut-in of these two pumps. The intervals between *cut-in* and *cut-out* levels of each pump would be determined by the capacities of the pumps, as before stated. But generally the pumps should be so arranged that the first to cut in is the last to cut out. If the sewer is very large it may be necessary to ascertain that the sewer has free discharge when flowing partly full, *i.e.*, the cut-in level of each pump must be sufficiently below the level of flow in the sewer at the time of cut in.

The float switches or electrodes should be connected to a plug and socket box in order that the order of cutting in of the pumps may be varied from time to time.* This prevents any one pump from having undue wear. It should normally be arranged that the stand-by pump does not cut in, because if it did an excessive quantity might be delivered through the dry-weather flow rising main.

The lowest cut-out level determines the degree to which the well is emptied. This is a matter of some importance, as on it depends the cleanliness of the well. If the well is not automatically emptied as far as possible, it becomes necessary for some periodic manual cleansing to be carried out. If, on the other hand, the well is arranged as a long chamber in which high velocities will occur when it is nearly empty, and if the floor of the well is sloped to about 1 in 6 (that is, a slope on which a man can stand without undue risk of slipping), but which allows organic matter to wash off easily, and if the suctions are placed in a channel of small capacity, it is possible to obtain reasonably clean conditions. The suctions of the pumps must be submerged about 12 in. in order that vortex formation does not occur. This means that the well is never empty below a level 12 in. above the ends of the suctions, which in turn will be about a diameter above the invert of the suction channel. The channel in which the ends of the suctions are placed should be small so that the final velocities on emptying the well will be sufficient to disturb any sludge or detritus that may collect, and so that the amount of scum which can collect on the surface of the sewage will be negligible. If the design is carefully considered in this direction, a suction well can be produced which requires no manual cleansing.

If large pumps are to be used, it will be advisable, from the point of view of economy, to instal high-efficiency pumps rather than those of the unchokeable variety, and this will necessitate fine screens with about ⅜-in. spaces. If the station is to be entirely automatic, the screens should be mechanically raked by float-operated machinery, and the screenings automatically washed from the cleansing device into a channel and discharged to a disintegrator pump which should operate at the same time as the raking device. The disintegrator pump may be fed with crude sewage from the well as well as the flow from the screenings channel, and part or all of the discharge from this pump may serve as the sparge for washing the tines. The screening mechanism and disintegrator should be operated by one starter, preferably controlled by differential floats, *i.e.*, that the mechanism should start when floats placed "above" and "below" the screens are at different levels. The disintegrator pump may also be used for the purpose of completely emptying the suction well, and may be either hand started when on this duty, or controlled by a time switch which causes the pump to operate for a short period every day, provided there is sewage in the well. The screens should have a submerged area of about 1 sq. ft. for every 20,000 gallons per day dry-weather flow.

*Several devices for effecting this automatically are obtainable in the United States.

Measuring Thickness of Pipe Coatings

At least two commercially practical methods of measuring the thickness of a coating on a steel surface without injury to it are now available, says R. L. Sanford, Chief, Magnetic Section, National Bureau of Standards, who described them as follows in a paper before the British Institution of Electrical Engineers:

An electrical enamel thickness gage is used to measure the thickness of enamel or paint on a flat steel surface. It consists of a gage head and indicating unit and operates on a 110-v., 60-cycle power supply. The reluctance of the magnetic circuit of the gage head when placed on a coated steel surface varies with the thickness of the coating. This reluctance in turn affects the inductance of the coil in the gage head which is compared by a bridge arrangement with the inductance of a similar coil in whose magnetic circuit there is an adjustable gap. The indicator is a sensitive electrical instrument connected as the detector in the bridge circuit through a copper oxide rectifier. The indicator is calibrated to read thickness directly in thousands of an inch.

A somewhat different principle is utilized in a type of instrument recently developed at the National Bureau of Standards. The instrument is a portable spring balance arranged to measure the force required to detach a permanent magnet from the surface under test. One form of the instrument is designed to measure the thickness of nickel coatings on nonmagnetic base metals and the other, which employs a smaller magnet and a stiffer spring is used to measure the thickness of nonmagnetic coatings on iron or steel. The force required to detach the magnet from a nickel coating increases with the thickness of the coating and is proportional to the thickness up to about 0.001 in. For nonmagnetic coatings on a magnetic base, the force decreases with the thickness. Both types are particularly valuable for determining local variations in thickness of coating.

After this picture was taken the snow depth was increased by a 4-day blizzard

Building Grades Designed to Reduce Snow Removal Costs

By G. F. DE LA MATER

County Engineer, Otsego County, Mich.

Persistent high winds in winter fill snow cuts as fast as they are opened. By raising the road and providing ample side ditches to receive the snow plowed off, this is avoided. Snow removal cost on a single mile of such construction was reduced $400 last winter.

OTSEGO COUNTY is situated at the apex of the watershed of the southern peninsula of Michigan. Six more or less famous trout streams, the Pigeon, Sturgeon, Black, Au-Sable, Manistee and Boyne, have their source in the county and flow out in all directions. The elevation of Gaylord, the county seat, is 1350 ft. and the highest land level is about 200 ft. above the town.

Due to the high altitude as compared to the surrounding country, the annual snow fall is heavy, being about 100 inches. But of greater consequence than the amount of snow is the constant high-velocity wind which blows three days out of every four during the winter months. This wind piles the snow up along the roadways to a great height, even when the snow in the fields is not more than a foot deep. The effect of this constant wind disturbance is to fill with snow every cut along the road, and if a snow plow leaves a ridge of snow on either side of the road, making a trench of the roadway, this trench is promptly filled with snow which must be plowed out, thus raising ever higher the banks along the roadside and making ever deeper the trench to be again filled with snow. The result of this constant plowing and drifting of the snow is to make banks eight to twelve feet high along the exposed roads and an enormous expense with heavy equipment toward the latter end of the winter to keep these roads open for travel. A mile of road which is protected by woods gives no particular trouble, but an adjoining mile which is exposed to the wind will cost several hundred dollars every winter for snow removal. It was this condition which set us to the task of solving the problem of these tough miles. Especially was this problem pressing because of the very limited budget for all highway work, this being one of the poor counties in the state.

We conceived the idea that if our road grades were raised sufficiently above the surrounding fields the wind would become a help instead of a hindrance by sweeping the snow off the road. We reasoned that if a wider ditch section were used it would provide earth for the elevation of the grade and at the same time afford storage for snow which has been removed from the roadway. Also, it is important to produce such a shoulder slope that a plow can push the snow over the shoulder and into the ditch without the danger of dropping a wheel over the edge and getting "stuck" because of the axle resting on the ground.

We were handicapped in carrying out this plan because our rights of way were all four rods wide and the expense of acquiring extra right of way upon all of our roads was entirely beyond our means. We thus found ourselves "between the devil and the deep sea," faced upon one hand by insurmountable snow removal costs and upon the other by impossible right of way expense.

We made the best of the situation by designing a grade cross-section which is less than the ideal but still can be used in a four-rod right of way. We make the surface of the grade 24 ft. wide, the ditch 2 ft. deep and 6 ft. wide at the bottom and the shoulder slope 4 on 1 with a back slope of 2 on 1. This makes, in level terrain, a total width of 60 ft. and a grade surface a foot above the surrounding fields. In all cuts of any appreciable depth, extra right of way must be procured. (Incidentally, we have found it easier in most cases to negotiate for a rod of width than for 16 ft. because the average farmer thinks more readily in terms of rods.)

Mr. De La Mater

For the most part our county is a porous gravel soil which requires little or no attention to drainage. In level land where no end haul is required and the traffic is light, we turn up a grade with a motor grader, or tractor and grader or a combination of both, by starting our backslope cut along a line 30 ft. from the center of the road, cutting straight down to a depth of 2.5 ft. and making a gradual

(Continued on page 49)

The Sewerage Digest

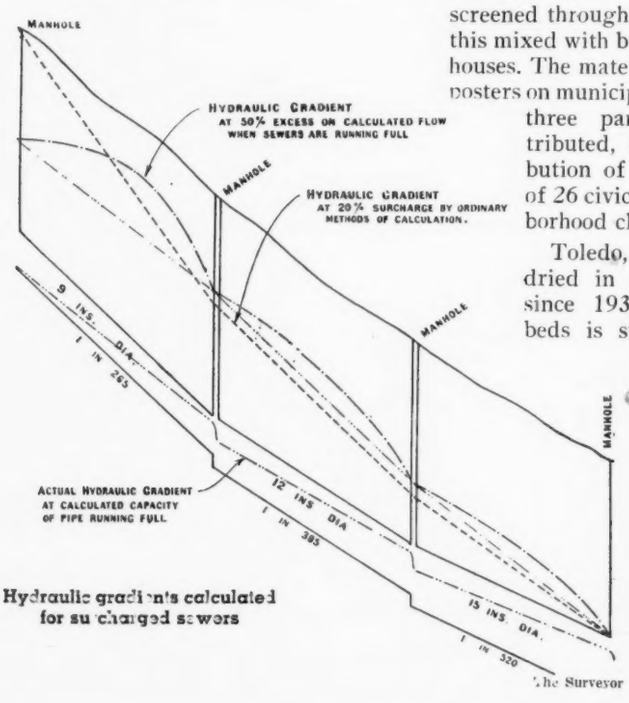
A Digest of the Sewerage Literature of the Month giving the main features of all the important articles published

Handling Grit in New York City

The Wards Island plant handles 1.2 mgd of sewage, most of it brought through combined sewers to two grit chambers before passing under the river. Here the grit is removed in mechanically cleaned channels, cleaned and discharged by pumps and pneumatic conveyors to overhead storage tanks. The grit contained sand, coal, scrap iron, timber, etc., which put the cleaning mechanisms out of commission. As a result of this experience, conveyor handling of grit has been substituted for grit pumping at the new Tallmans Island plant.[C28]

Surcharge in Sewerage Systems

There has recently been much discussion by English engineers of the possibility of reducing the design sizes of sewers by allowing for the surcharge that would take place if the quantity reaching the sewer should exceed that ordinarily used as its "flowing full" capacity; such surcharge utilizing the upper part of a line of uniform-size pipe where it increases from one of smaller size. (With complete surcharge, the upper end of each line would be full, even though receiving little or no sewage except what backs up). The hydraulic gradient in such section would be a curve convex upward, with a maximum ordinate near the mid-length. Escrit calculates that "a small degree of surcharge may cause a considerable degree of increased discharge." If a length of uniform size and grade, fed uniformly throughout its length, is surcharged to crown level at its upper end, the effective gradient is about 2.88 times the actual gradient of the pipe itself, giving a velocity of flow 1.7 times the normal; this factor decreasing with the amount of sewage entering the upper end from the sewer above, becoming small for large sizes where the changes of size are relatively small.[D25]



Hydraulic gradients calculated for surcharged sewers

Air-Dried Sludge As Fertilizer

Rotherham, England, had several years' accumulation of air-dried sludge on hand but few farmers in the immediate neighborhood. By an intensive 6 weeks' campaign it stimulated a demand for it as fertilizer for private gardens, golf links, etc., and during 5 months (January to May) disposed of 5,000 tons—at one time as much as 100 tons a day. Perhaps the most effective inducement was arranging with a trucking company to deliver it at a half of a third that previously charged—4s. 6d. per 2-ton load under a 2-mile haul. Preference was shown for sludge screened through a ⅜" screen, and for this mixed with burnt sludge for greenhouses. The material was advertised by posters on municipal trucks, large signs, three pamphlets widely distributed, and talks and distribution of samples at meetings of 26 civic organizations, neighborhood clubs, etc.[D21]

Toledo, O., has sold sludge dried in covered sludge beds since 1934. Near the sludge beds is sufficient low land to receive 200,000 tons of sludge, and onto this is discharged about three-fourths of the sludge, taken from the bottom of the digester hoppers so as to include all grit and inorganic material. About 1250 tons a year is dried on the beds to 7% to 10% moisture with a dried depth of 3"-3½". This is ground in a Gruendler crusher, screened through ⅜" holes, and bagged in preclosed paper bags holding 81½ lbs., all handling and bagging being automatic. With the latest equipment the cost per ton is 67 cts. for labor, $1.12 for bags, 11 cts. for electric power, 4 cts. for supplies and repairs, and 12 cts. for rental of packer —$2.06 total. This is sold at a city market in a central location. In 1938, 600.22 tons was sold for $6,180.45, the price being $1.00 per cwt. up to 400 lbs., down to $6.50 per ton for 50 tons or over. An experienced salesman was employed; a miniature plant was displayed and samples given away at a municipal exposition and at booths at three nearby county fairs, and a prize offered for the best name for the fertilizer ("Tol-e-Gro" was that chosen from 125 submitted). The manufacturing cost in 1938 was $1,266.45, giving a gross profit of $4,913.99; deducting advertising and promotion expenses, the profit was $3,875.25, not including overhead and fixed charges.[H19 & 23]

Odor Control for Sludge Storage

At New York's Wards Island plant, waste sludge is stored temporarily in large elevated tanks until barged to sea. The location of the tanks necessitates effective odor control. The method employed is probably unique. In the storage building, under the tanks, are equipment for treating the air with both activated carbon and ozone. Fresh air is drawn in by forced draft through monitors on top of the building, passes over the tops of the sludge tanks, carrying with it the odorous gases, and is then drawn through air filters and canisters of activated carbon, then dosed with ozone and discharged above the roof. The ozone equipment, with a rated capacity of 61 grams of ozone per hour, delivered 56 grams, dropping to 42 after 24 hrs. of service in humid weather. The ventilating fan has a capacity of 15,000 cfm, representing a displacement of air in the upper part of the building each half hour. Activated carbon alone removed the odor substantially, but not completely, and addition of ozone completed the job.

To take care of the odors originating from loading the vessels and transport-

LOOK through to the future a century hence, you men who are planning and constructing cast iron underground mains, and what can you be sure of! Just this: cities may be destroyed—mains abandoned or relocated—but there will be a *hundred years or more of useful life* in every length of cast iron pipe, whether it be pit cast or centrifugally cast by the Super-de Lavaud chill-free process.

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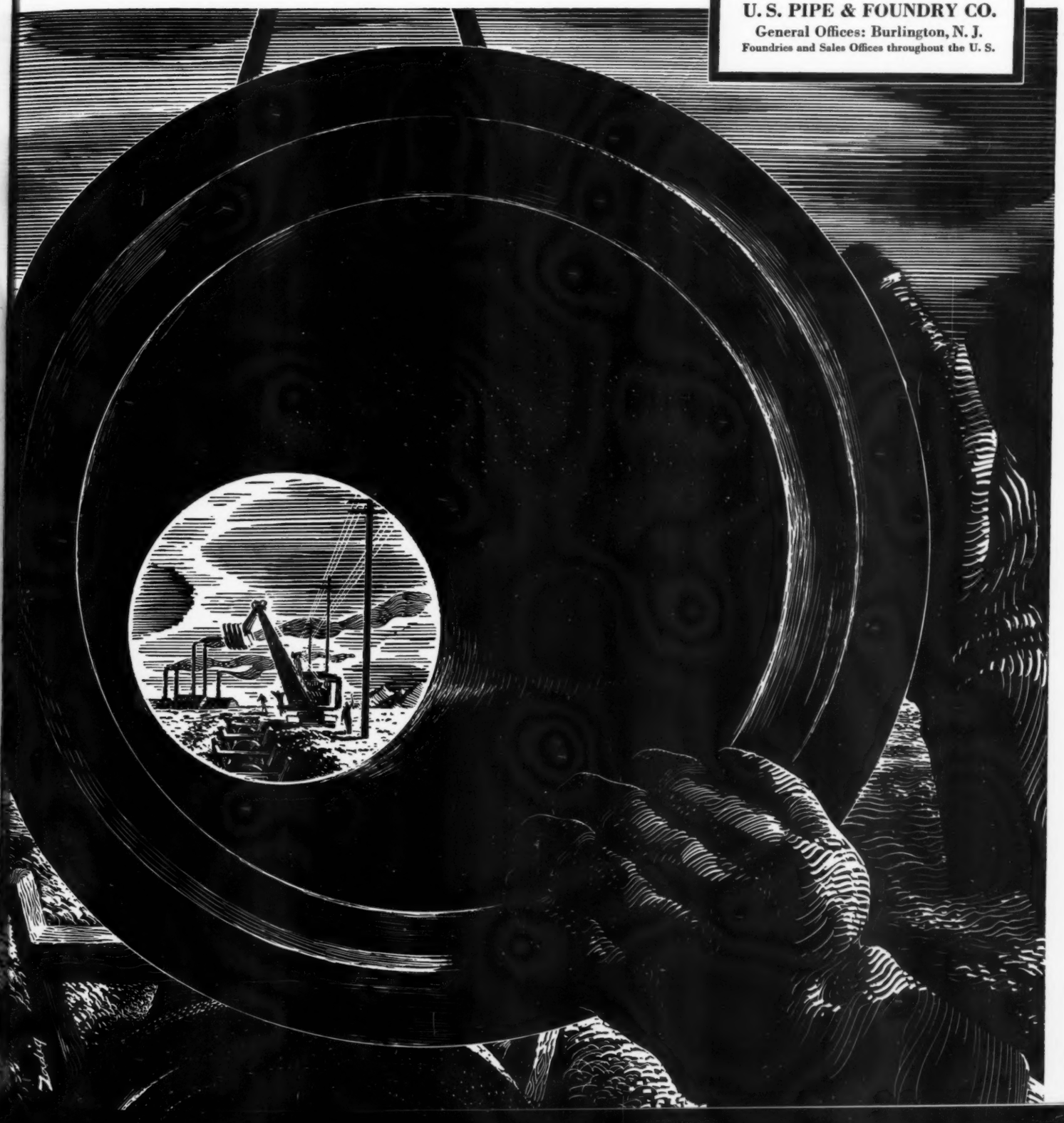

ing the sludge to sea, gas vents of the storage tanks of the three vessels have been equipped with canisters of activated carbon through which the escaping air must pass.[C28]

Acid Trade Wastes

Acid trade wastes in sewage may not only interfere with biological operation of treatment plants and cause undesirable growths and odors therein, but may attack sewers of concrete, cast iron or steel and parts of pumps and other mechanical plants. Therefore neutralization at the treatment plant is not sufficient—it should be effected at the plant of origin. This need not include sedimentation of the solids, which, if neutralized, can be discharged into the sewer. Milk of lime is recommended for neutralization of most classes of acid wastes.[D20]

Utilizing Sludge Gas at Peoria, Ill.

A power plant to utilize sludge gas went into operation at the plant of the Greater Peoria Sanitary Dist. in May, 1936. A 535 h.p. gas engine is direct connected to the blower, which uses 70% of the power consumed at the plant, and a 300 h.p. generates current for some 50 motors in the treatment works. A 50,000 cu. ft. gas holder is provided. To remove hydrogen sulphide from the gas, three iron oxide purifier boxes are used, costing 1.5 cts. per M cu. ft. of gas (capital and operating cost) to reduce the H_2S from an average of 115 grains per 100 cu. ft. to 10 grains. The larger engine uses 10,200 Btu per brake horsepower, the smaller engine 12,000 Btu. Total cost of engines and equipment, $111,057. Operating cost of gas power plant, $5,900 a year, of which $3,000 is labor and $1,260 is lubricating oil. Annual saving in cost of power, $31.000.[H20]

Uses of Chlorine in Sewage Treatment

Simple chlorination is used to effect Sterilization—oxidation—for destruction of pathogens, sulfate splitters, acid formers, filamentous organisms, or organic coatings; for chlorination of grease, or stabilization of organic matter. Chlorine and its derivative iron salts can be used for reaction with sulfides to release free sulphur or form ferrous sulfide. Chlorine or its derivative trivalent iron salt can be used for electrolyzation of colloids—coagulation of suspended solids—for coagulation of finely dispersed suspended solids, chlorination of protein, formation of ferric hydroxide, formation of ferric jell in biological units, and granulation of digesting and digested sludge.

Euipment is under active consideration for several plants, time-rated and automatic, which will vary the dose relative to both rate of flow of sewage and to changes in its strength.[C30]

Sludge Gas Engines at Los Angeles

Operation for 2½ yrs. of a 200 h.p. gas engine direct-connected to an 18 in. centrifugal pump for lifting effluent, together with use of purchased current for 1200 h.p., led to installation of another 250 h.p. gas engine. Cost of maintenance, operation and overhead was $3,054.67; equivalent commercial power cost $20,626.08, with current at 0.65 ct. per k.w.h. Manufacturer of first engine contracted for maintenance and upkeep at .03 ct. per h.p.hr.; actual cost to him estimated at .01 ct. cylinder heads and pistons very clean after long, continuous operation.[E11]

Imhoff Tank Operation

A 1.3 mgd Imhoff tank plant at Great Neck, N. Y., has operated for 8 yrs. with no foaming trouble that was not stopped quickly by reversing direction of flow through the tank and drawing sludge. No lime is used and pH is between 6.6 and 6.8 at all times, but sludge

is always well digested and inoffensive. Once a large amount of fuel oil illegally discharged into the sewer coated the solids, causing them to float and the tank filled with an oil-sludge emulsion, foaming became uncontrollable and the entire tank was emptied and thoroughly cleaned. Clarified sewage is used for hosing down tank walls and gas-vents, doing better work in less time than previous hand cleaning.[C32]

High-Rate Filters at Ft. Dodge, Ia.

The Ft. Dodge plant, put into operation in 1938, provides secondary treatment on four trickling filters, used in two stages, three of conventional 4-arm design, the fourth with 8 arms which can be used as a high-rate filter and is used primarily as a roughing filter or can be used at low rates. It has not been used at high rates long enough to permit definite conclusions as to its efficiency.[J4]

Sewage Treatment for a Summer Resort

The population of Virginia Beach, Va., varies from 2,500 in winter to 40,000 in summer. A treatment plant recently constructed to meet this variable demand, consists of a trickling filter 120 ft. diameter, preceded by screens, detritor and 2 primary clarifiers 40 ft. diam. by 7 ft. deep; followed by chlorination, final clarification; sludge digested and dried on beds; these for winter flow. In summer a third clarifier (as secondary) 60 ft. diam. will be used, chemicals and chemically precipitated sludge added and mixed; the trickling filter will be run at a high rate and serve more for building up the D. O. content than as an oxidizing device. To provide for minimum and maximum rates of filter, a special low-head rotary distributor is used which has double channel distributing arms, one for low flows and nation, final clarification; sludge di- Final chlorination of effluent with 2-hr. detention. With maximum rates, flocculation precedes primary clarification, and flash mixing and flocculation precedes secondary clarification. Two digesters, 40 ft. diam. by 16 ft. deep, the primary heated, the secondary not; sludge drawn to covered bed 50 x 100 ft. Supernatant and filtrate returned to plant influent. Cost $155,000.[E10]

Lining Old Sewer with Corrugated Metal Flume

The invert of an old brick sewer 6′ 6″ horizontal diameter, 43 yrs. old, in Rochester, N. Y., was in bad shape for about 1,000 ft. and was replaced with half-round corrugated iron flume, bituminous coated. Work was done while the sewer was in service, and could be halted quickly in case of storm. (It was a combined sewer). While construction was in progress the sanitary sewage was carried by a corrugated pipe from a temporary dam above the work to another below it. By drilled holes in the brick just above the top edges of the flume and cinch anchors, supporting metal plates to which nuts had been welded, the flume plates, 4 ft. long, were bolted in place, the ends bolted together, and the circumferential joint sealed with hot asphalt, and the top edges, fastenings, etc., covered with cement-sand gunite, and the same material used to fill the space under the flume.[E12]

Sewage Disposal in Germany

Of the 28 million population in Germany provided with sewers, the sewage of 23 million is treated; 5 mil. by screens alone, 7 mil. by settling tanks alone; 1.4 mil. by trickling filters, 1.8 mil. by activated sludge, 7 mil. by irrigation fields, and 0.8 mil. by fish ponds. Screens are obsolete. Settling tanks closely follow American practice. Recent tanks in 25 cities are supplied with sludging machines. Sludge digestion tanks are operating in 115 cities, 61 utilizing the sludge gas. Open earth

ponds are used for sludge digestion in several cities, about 4 times the capacity of heated enclosed ones but of much lower construction costs. Vacuum filters are not used; digested sludge is used as fertilizer, either air-dried or liquid. Only 2 old and 1 new chemical treatment plants in service. One city of 300,000 filters tank effluent through rapid sand filters, giving an effluent betwen plain settling and biological purification. Trickling filters follow U. S. practice, including experiments in high rates. Activated sludge is used in 21 cities with 1.9 mil. inhabitants, using diffused air with 4 to 8 hrs. aeration. Some form of land irrigation is used in 69 cities, 160 to 400 inhabitants per acre; is more expensive than biological treatment, but is being re-introduced for conservation of fertilizers. Fish ponds are used by 12 cities, yielding about ½ lb. of fish per capita per year. There is increasing compulsion to prevent further pollution of German rivers.[G11]

Treatment Plant for Des Moines, Ia.

Des Moines is completing a $1,500,000 treatment plant, 20 m.g.d. capacity, involving sedimentation, trickling filters and separate sludge digestion. Filters were used instead of activated sludge because they would employ more local labor, and would probably cost less to operate. Will include mechanically cleaned bar screens, shredders, grit chambers, grease remover, flocculator, primary settling tanks, dosing tanks, trickling filters, secondary settling tank and aeration cataracts; digestion tanks and sludge beds. To maintain constant rate through plant, final settling tank effluent can be pumped to raw sewage. Due to the use of unskilled labor and intricate nature of the work, the engineers made more than 1,000 drawings, a model of the whole plant and detail models of individual structures.[E13]

Bibliography of Sewerage Literature

The articles in each magazine are numbered continuously throughout the year, beginning with our January issue.

c. Indicates construction article; *n,* note or short article; *p,* paper before a society (complete or abstract); *t,* technical article.

D *The Surveyor*

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20. *p.* Neutralization of Acid Trade Effluents. By J. McNicholas. Pp. 459-460.
21. *p.* Disposal of Air-Dried Sewage Sludge as a Manure. By J. W. Finch. Pp. 468-469.
22. *p.* Power Factor Correction as Applied to Sewage Works. By E. H. Arrowsmith. P. 477.

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23. *p.* Importance of Local Conditions in Sewage Works Design. By J. T. Calvert. Pp. 491-492.
24. *p.* Sunderland Sewer Outfall Works. By J. E. Lewis. Pp. 501-502.

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25. Conditions of Surcharge in Sewerage Systems. By L. B. Escritt. Pp. 507-509.
26. Impermeability with Special Reference to Gaugings. By E. D. Grubb. Pp. 515-516.

E *Engineering News-Record*

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12. Half Soles Save on Old Sewer. By E. M. Van Gelder. Pp. 48-49.
13. Relief Labor Builds a Sewage Treatment Plant (Des Moines). Pp. 69-70.

H *Municipal Sanitation*

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19. From Sludge to "Tol-e-Gro" (Fertilizer). By A. H. Niles. Pp. 134-136, 152.
20. *p.* Power Production at Peoria Saves $24,000 Yearly (Sludge Gas). By J. R. Longley. Pp. 137-140.
21. Vacuum Filter Costs Reduced at New Brunswick. By D. M. Vail. Pp. 142-143.

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23. From Sludge to "Tol-e-Gro" (Fertilizer). By A. H. Niles. Pp. 177-179.
24. Maintenance of Imhoff Tanks. By L. M. Johnson. Pp. 180-182.
25. Tallmans Island Sewage Treatment Works. By R. H. Gould. Pp. 185, 186, 199, 202-206.
26. Southwest Treatment Works of Chicago. By W. H. Trinkaus. Pp. 221-225, 230, 236.

G *Water Works & Sewerage*

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12. Grit Chamber Velocities Controlled by Parshall Flume. By S. T. Barker. Pp. 127-131.
13. Sludge Filtration: Sludge Conditioning. By L. W. Van Kleeck. Pp. 135-139.
14. Albemarle's (N. C.) Combination Wastes Disposal Plant. By G. S. Moore. Pp. 143-145.
15. Principles of Sewer Flow. By J. D. Watson. Pp. 147-150.

P *Public Works*

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17. How the Moisture Content of Sludge Affects Digestion. Pp. 14-15.
18. *n.* A New Type of Sewer Form. P. 18.
19. Laboratory and Plant Trials of Chemical Coagulation. By F. K. Burr. Pp. 21-22.
20. Taking the Rattle Out of Manhole Covers. By R. V. Terrill. P. 33.
21. Suggestions for Planning an Incinerator. Pp. 44-45.
22. Sewage Disposal Problems of Unsewered Municipal Areas. P. 46.

The Waterworks Digest

Abstracts of the main features of all important articles dealing with waterworks and water purification that appeared in the previous month's periodicals.

Delaware Water for New Jersey Cities

An aqueduct in the abandoned Delaware & Raritan canal to bring water from the Delaware river to cities of northeastern New Jersey is recommended to the legislature. Flowing by gravity 49 miles in a closed aqueduct to Bound Brook, it would be pumped to a 600 mg reservoir, filtered, and flow through 21 miles of a 200 mgd main into the existing Wanaque system at Newark. The state already owns the canal and presumably right to 210 mgd of water from the river. Twin rectangular concrete conduits are considered, because of low clearances at highway crossings. Filtering through 200 pressure filters is planned. Total cost about $33,700,000.[E14]

Field Control of Earth Embankments

Suitability of material for compacted earth fill should be determined only after careful study of the borrow pits, subjecting samples to thorough geological, practical and laboratory examination. Laboratory findings regarding permeability, consolidation and angle of internal friction should be translated into density requirements in the field, which density should be measured directly, and correlated with moisture content, number of passes with the roller, and the material being used; then the contractor can tell by a glance at the experimental correlation chart how many passes he must make to fulfill the requirements of his contract and why he is required to work within specified moisture limits.[L6]

Zeolite Softening at Clarksburg, W. Va.

March 2nd Clarksburg put into operation a 3 mgd addition to its rapid sand filters and a 4 mgd zeolite softening plant, both housed in an old boiler house 47x67 ft. in area; steam operation having been discontinued in 1917. Under the filters and softeners is an 80,000 gal. treated water basin. The softeners are open, gravity, downward-flow greensand, 225 ft. square. Zero softened and filtered unsoftened water are mixed in proportion to give 80 ppm hardness. (River water reaches 392 ppm at times and fluctuates widely.) Part of the time filtering before softening will not be necessary. Both filters and softeners are controlled by a master control system. Transite pipe is used for underdrains, troughs and brine distributors. The operating floor and a walkway in the pipe gallery are of steel grating.[G16]

Water Spreading in Utah

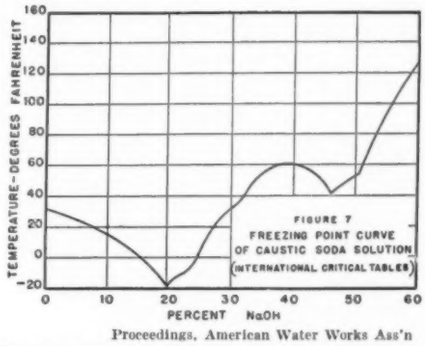
Water spreading, practiced for some years in California, is being experimented with near Centerville, Utah. Water was diverted into a narrow pit 2400 ft. long in relatively porous material on a side hill, at the rate of 3 cfs, about 350 acre-feet being diverted between Dec. 22, 1937, and June 4, 1938. In 1938, ground water levels in the land below were higher than for 10 to 15 years previous, but not in neighboring areas. "It is clear that the stored water is passing through the Bonneville and other deposits on the mountainside into the alluvian and lake sediments of the valley."[L4]

Improving Bacterial Quality of Water

All water that can possibly contain bacteria of any intestinal disease should be chlorinated sufficiently to insure at least 0.5 ppm residual after 2 hours—1.0 ppm if there is considerable pollution. The total number of 37° bacteria should average not more than 2. Practically all presumptive tests in lactose or dextrose broth should be negative. Spend more time trying to eliminate all bacteria and less in trying to prove that certain types of gas formers do not belong to the coliform group or other dangerous kind.[G12]

Concrete Dam Design and Construction

Refinements in design of general shape and dimensions of a gravity concrete dam have less effect upon stress distribution and safety than refinements in the construction procedure. This conclusion is derived from measurements at the Norris Dam of temperature of the concrete (by 155 thermometers cast in it), uplift pressure (by 29 Bourdon gauges), strain (by 72 strain meters cast in dam), stress (by stress meters), joint opening (by 49 meters cast across the joints), foundation deformation (by several methods) and horizontal deflection. These show that stresses due to temperature change are greater than those due to water load; but the former do not tend to cause failure except as they may cause serious cracks. There was no indication of excessive uplift.[E15]



Proceedings, American Water Works Ass'n

Freezing point of different solutions of caustic soda

Sulfur Dioxide and Caustic Soda Hazards

Containers of sulfur dioxide should not contain more than 125 lb. of that material for each 100 lb. of water the containers will hold (legal limit set by the ICC); in which condition a container will be completely devoid of gas space at temperatures above 147.2° F, and higher temperatures would subject the cylinder to dangerous pressure. Pipes, tanks, etc., which it enters must be kept free of moisture, or sulfurous acid will be formed, which is quite corrosive. Valves should be of good brass, with deep packing recess, using rubberized asbestos packing. If tank leaks, immerse in water, preferably alkaline. The gas is quite heavy and settles; causes suffocation, weeping, and in liquid form injury to the skin, but not death.

Caustic soda can be handled in black iron pipe with cast iron fittings, monel-trimmed cast iron valves. 50° Baumé caustic soda freezes at 50° F, and pipes, tanks, etc., outdoors or elsewhere where temperatures may fall below this, should be heated by a steam pipe alongside it, both wrapped together with insulation; and when not in use should be purged with air to prevent freezing. But the soda must not be heated above 125° F. Caustic soda rapidly absorbs

moisture and carbon dioxide from the air, and must be kept free from contact with it. It destroys clothing and shoes, may seriously injure the skin, and those handling it should wear goggles, and rubber gloves, boots and aprons.[A59]

A Reservoir Used for Recreation

Springfield, Ill., in 1935 built a large reservoir for a water supply replacing a polluted stream. The reservoir has an area of 6.72 sq. mi., a shore line of 57 mi., and a drainage area of 265 sq. mi. It is one of the largest lakes in the state and is used for recreation by people from all over the state. The city owns all the marginal land, part of which is leased to individuals and clubs, the remainder containing three large picnic parks, a golf course, wildlife sanctuary, two large bathing beaches, a lake nursery, and spots to fish from. Last summer over 72,000 persons used the bathing beaches, where free lessons were given in swimming, and almost 400 boats, from sail boats to canoes, used the lake. Thousands fish there, the lake being stocked with fish for their benefit. The water is filtered and chlorinated; the coliform bacteria average 27 per 100 ml (the previous river supply contained 20,835), and there is not believed to be any danger from this use of it. The city expects that revenue from these uses of the lake shores will pay for operation and maintenance.[F31]

Discontinued Services in Chicago

In 1936 there were about 120,000 services connected to Chicago's mains that were not being used (many never had been)—about 520 miles of pipe, from 10 to 60 yrs. old; many of them leaking. Prior to 1895 taps were made by driving brass plugs into smooth holes, and there still were about 15,000 in use in 1936. Removal of all these was begun that year as a WPA project, and 12,000 unused services have been cut off; 8,000 driven taps replaced. This has reduced leakage by a considerable amount.[F32]

Flood Control and Water Supplies

Flood control reservoirs have been authorized on the Allegheny-Monongahela basin for reducing flood heights in the Ohio valley, but may be used for improving the quality of the river water also. The Allegheny is acid intermittently and increasing in hardness. Sudden flood conditions wash deposits of sewage sludge down stream and, producing more dilution of the acids, reduce their inhibitive action; and highly concentrated waves of organic and bacterial pollution pass down stream, imposing on water purification plants temporarily pollution loads far above their design capacity. It is proposed to so operate the reservoir as to neutralize the acid and dilute the mineral load of the river and furnish additional oxygen; timing discharges from the reservoir to effect this. Results expected are: Double the low flow of the Allegheny, neutralize acid wastes, lower the hardness and lessen manganese effects, taste, odor and color; furnish additional oxygen for oxidizing organic matter.[A54]

Acid Wastes and Sewage Pollution

The removal of the existing acid wastes from the Ohio river, or their substantial reduction, would bring about a serious overburdening of purification plants unless provision be made for extensive treatment of sewage now discharged into the river. If industries along the river should neutralize all their acid wastes before provision is made for the proper treatment of sanitary wastes, purification of the river water for city supplies would have to be increased greatly. Reduction of sewage and of acid waste pollution should parallel each other.[A55]

Bibliography of Waterworks Literature

The articles in each magazine are numbered continuously throughout the year, beginning with our January issue.

c. Indicates construction article; *n*, note or short article; *p*, paper before a society (complete or abstract); *t*, technical article.

A *Journal, Am. Water Works Ass'n*
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53. Beaver River Supply and Low-Flow Augmentation. By C. H. Young. Pp. 419-435.
54. Flood Control and Water Supplies. By D. D. Rait. Pp. 434-450.
55. Industrial Uses of Ohio River Water. By R. B. Smith. Pp. 451-453.
56. Water Systems on the Ohio River. By P. D. Simmons. Pp. 454-458.
57. National Water Policy. Committee Report. Pp. 459-461.
58. Organization of Water Resources Planning. By H. H. Barrows. Pp. 462-480.
59. Hazards of Sulphur Dioxide and Caustic Soda. Committee Report. Pp. 489-501.
60. Specifications for Gate Valves. Adopted Jointly by the A.W.W.A. and the N.E.W.W.A. Pp. 502-516.
61. Physical Property Records. By H. B. Gotaas. Pp. 517-525.
62. Handling Complains About Quality. By G. E. Arnold. Pp. 526-535.
63. Complaints Concerning Water Service. By F. S. Porter. Pp. 536-541.
64. Developments in Water Treatment. By W. Rudolfs. Pp. 542-549.
65. Some Trouble-Makers in Reservoirs. By R. H. Holtje. Pp. 550-557.
66. Progress in Lime-Soda Water Softening. By G. A. McBride. Pp. 558-569.

D *The Surveyor*
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15. *p.* Sterilization and Cleaning of Slow Sand Filters. By D. Ronald. Pp. 485-487.
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16. *p.* Water Supply of Stranraer. By J. M. Thomson. Pp. 511-513.

E *Engineering News-Record*
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16. Selling Water to the Public (Indianpolis). P. 61.

F *Water Works Engineering*
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31. Recreational Development of Lake Springfield. By G. S. Bonn. Pp. 414-418.
32. Problem of the Abandoned or Discontinued Service. By L. D. Gayton. P. 434.
33. *p.* Safeguards Required for Ground Water Supplies. By L. E. Sherman. Pp. 437, 438, 441.
34. Payment of Water Bills at Banks in San Francisco. By N. A. Eckart. P. 445.

G *Waterworks & Sewerage*
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16. Soft Water Comes to Clarksburg, W. Va. By S. G. Highland. Pp. 123-126.
17. On Pouring Joint Compounds. By D. R. Taylor. P. 131.
18. Main Break Detectors. By A. F. Theard. Pp. 140-142.

J *American City*
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7. Dual Water Supply for Coulee's Model Town. By H. W. Young. Pp. 50-51.
8. Subaqueous Pipe Line Serving Hancock, Mich.
9. Water Rates and Service Charges. Pp. 83, 85, 87.

K *Proceedings, Am. Soc. Civil Engineers*
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3. Evaporation Experiments. By H. C. Hickman. Pp. 596-606.
4. Design of a High-Head Siphon Spillway. By E. Rock. Pp. 607-618.

L *Civil Engineering*
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6. Field Control of Compacted Earth Fill. By H. F. Peckworth. Pp. 221-223.
7. Forecasting Stream Flow from Snow Surveys. By G. D. Clyde. Pp. 237-239.

P *Public Works*
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20. Laboratory and Plant Trials of Chemical Coagulation. By F. K. Burr. Pp. 21-22.
21. Brom-Cresol Green-Methyl Orange as Alkalinity Indicator. By F. M. Hull. P. 34.
22. *n.* Adding Chemicals to Water Supply in Buildings. P. 35.
23. *n.* Washing Sand Filters in Hartford. P. 35.

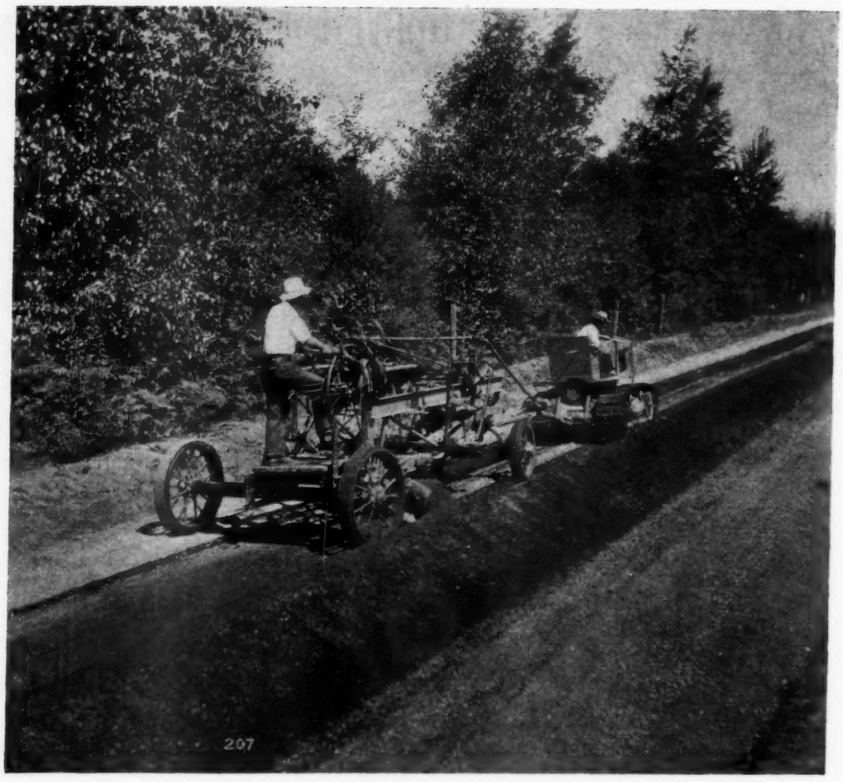
T *Technique Sanitaire*
February

Comment Proteger Les Usines des Eaux Contre Les Attaques Aeriennes. Pp. 29-32.

No Injunction for Stream Pollution

In a suit by a farmer to enjoin the pollution of a stream by a disposal plant, the Maryland Court of Appeals (Livezey v. Town of Bel Air, 199 Atl. 838), conceding that a municipality is liable for constructing and maintaining sewers and drains so as to injure another in the use of his property, held that injunctive relief should not be granted except on a clear and satisfactory showing of grave and irreparable injury to private rights. "Where the effect of the injunction will be to endanger the public health and security, no injunction should issue until the municipality is given an opportunity of abating the injurious condition by adopting some substitute, by correcting any faults in the operation of the system, by acquiring the property damaged, or by other appropriate measures. . . . It is obvious that the sudden abandonment of a sewerage system designed and used to afford to a town of the size of Bel Air facilities for the disposal of its sewage and household waste might well result in the generation and spread of pestilence and disease, whereas the inconvenience to the complainant is largely delay in recovering compensation for the harm to his interests." It was therefore held that no injunction should be issued until the municipality had a reasonable time in which to correct the conditions complained of.

This is the fifth installment of this article. Another will appear in the June issue; and thereafter from time to time. Our particular appreciation for assistance in preparing this section goes to Messrs. Taylor, Martin, Wiggin, Chrystie, Nikirk, Milligan, Conzelman, Davis, Richardson and many others.



A tractor and blade grader on an oil mix-in-place job. The tractor is put in high and the material is rolled ahead and to one side of the blade, working it across the road and back until it is ready to spread (Courtesy Cletrac)

How to Maintain Highways and Streets

Prepared by
W. A. Hardenbergh and Consultng Staff

Betterments in Maintenance

WHAT Betterments Include.—Accounting methods are not standardized in regard to what are betterments, although the U. S. Bureau of Public Roads is encouraging adoption of uniform accounting methods, and some progress has been made. The State of Nebraska, classifies, among other items, the following as betterments:

Grading of a construction nature accomplished with maintenance funds, such as improving vertical sight distance over hills, flattening horizontal curves, improving alinement, raising and widening fills, channel changes and original application of a clay surface to a road not previously surfaced.

Drainage structure betterments include the work carried on with maintenance funds, such as first construction of bridges, pipes, boxes, flumes, riprap, or their replacement by a larger or more permanent type of structure; or the extending of existing structures. Also guard rail construction at a new location.

Gravel surfacing, with maintenance funds, on a road not previously graveled. Also subgrade stabilization betterment of a subgrade not previously stabilized.

Pavement betterment work, such as widening pavements, addition of curbs, and relaying pavement that has been removed in order to make improvements in alinement, grade or drainage facilities.

New bituminous mat and oil sand paving, and also the first seal coat if applied during the same or following construction season, but not preparation of grade. Repairs to these types, such as addition of new aggregate, fines or bitumen, and remixing and major repair to stabilized base are included in betterments.

Several other items are included in betterments in this classification, including signs, shops and garage improvements, detour construction and gravel for detours.

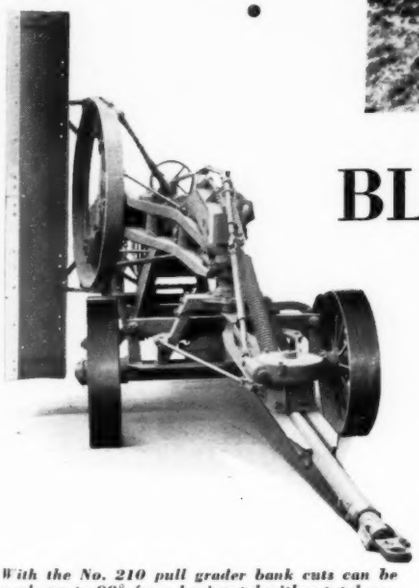
A. J. Wiggin, Supt. of Maintenance, Maine Highway Commission, states: "All work done by the Maintenance Division is considered maintenance and is paid for out of maintenance funds, this work including reconstruction of short sections, or those that have been built for several years and are inadequate; replacements with more permanent types of surface; maintaining detours"; and similar other items.

Widening, improving alinement, reducing crown, resurfacing and similar work are important factors in improving a highway system. In magnitude, these perhaps present the largest construction operations that the maintenance forces are called upon to do. Classification of the costs of such work under the head of maintenance though sometimes done, is doubtful policy, since maintenance aims only to keep a street or highway up to the standard attained by the construction forces, whereas all of the items mentioned above are definitely betterments, and should be so charged.

Before any work of this sort is undertaken, a careful study of the road to be improved should be made. This study should consider particularly those factors that need to be improved in order that the road will be safe, pleasant to drive on and,

Heavy duty motor patrol with 66 H.P. diesel engine mounted over driving wheels, one-piece narrow frame for full visibility, centralized hydraulic controls, heavy duty transmission, and other features providing a unit for heavy construction and maintenance.

Bulletin No. 237.



With the No. 210 pull grader bank cuts can be made up to 90° from horizontal with a total vertical reach of 11'0". Bulletin No. 234.

BLADING—BANK CUTTING

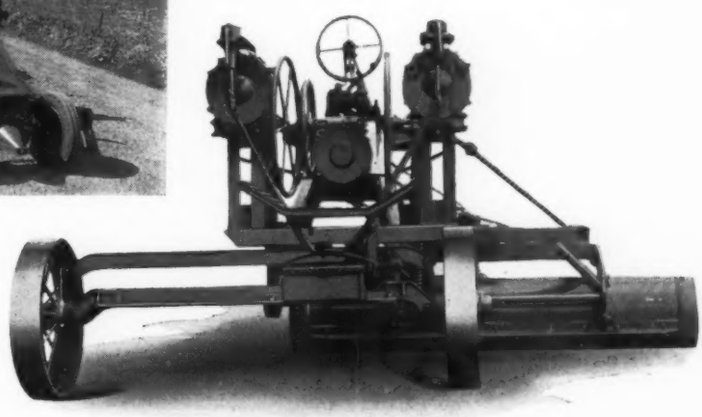
LET GALION GRADERS DO IT

Motor patrol or leaning wheel types . . . Galion builds a complete line in a type and size for ordinary blading or the toughest kind of construction work such as cutting down banks or grading for a new road.

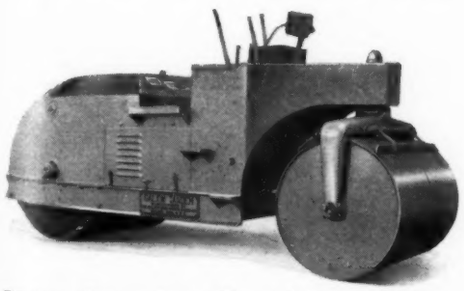
Galion graders are built to meet every condition you may encounter . . . have all the mechanical excellence and modern developments to provide greater flexibility and smoothness of operation. Let us send you literature covering the grader, roller, spreader, and rooter you need for that road building and maintenance job of yours. Write today.

Two master model motor patrols doing a nice job of blading and spreading on this highway. Can be furnished with either diesel or gasoline engine. Have hydraulic control and double drive.

Also Junior Patrols for general maintenance.



Right—Moldboard on the No. 210 pull grader can be side-shifted 10" right or left; angle bank cutting—90°; reach bank cutting—11'0"; shoulder reach—80". Bulletin No. 234.



Tandem rollers—with variable weight from 5 to 14 tons. Gasoline or diesel power. Also 3-wheel, portable and trench rollers.

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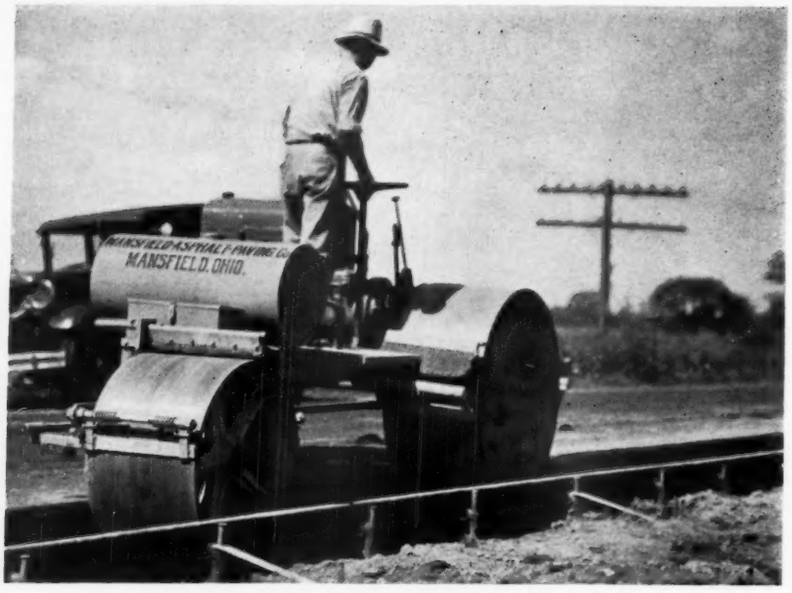


The Galion trench roller is excellent for widening work

so far as is economically possible, adequate for the traffic that will come upon it as regards volume, weight and speed. Such a study is necessary to determine how much, or even if any, expenditure is justified.

This does not mean that a traffic-volume study must be made of every road before even a surface treatment can be applied to it. The man in charge should be familiar with conditions on all the roads for which he is responsible; he should observe them as a routine matter in wet weather and in dry; at times of normal and of heavy traffic; in spring, in summer and in winter. He should pay particular attention to those roads on which he contemplates spending money. The information gained from this observation and study should be adequate as a basis for a well-planned and considered program.

The decision to improve should not be a hasty one, because prior to making these improvements, certain preparatory work should be done. This work includes that necessary to make the highway ready for betterment, and may cover one or several of the following: Drainage, improvement of sight distance, grades and curvature; widening, extending culverts or improving the approaches to them; reducing the slopes of cuts and fills; and similar work.

Drainage has already been considered quite fully. It is most essential that both surface and subsurface drainage be adequate. Inspections in the early spring and during heavy rains will often give valuable information on the capacity of ditches and culverts, the condition of the soil as regards moisture, and the water that stands on the road surface after a rain.

Sight distances on horizontal curves depend so much on local conditions that no set rule can be applied. Experiences gained from driving over the road as a stranger would do, and the knowledge and judgment of the engineer or foreman must be combined to determine the basis and the need for improvement. The same applies to sight distances on horizontal curves. Proper warning signs will help, of course, where needed conditions cannot be obtained.

In considering grades and their possible reduction, the reduction of curvature, and widening, cost is likely to be an important factor. The possibility of doing such work within permissible limits of cost may depend upon the equipment available. Modern powerful motor graders; bulldozers and trailbuilders; and the more modern dirtmoving scrapers, are all adaptable to doing work of this sort quickly and cheaply. They are also useful for a wide variety of other town and county highway work, as for reducing slopes on cuts, which work will often pay for itself through decreased maintenance costs. Slope reduction can often be combined with other work, as widening, or improving horizontal sight distances on curves.

The improving of culverts and bridges where the roadway is too narrow, or that are not so located in respect to the centerline of the roadway as to be safe for motorists, should also be done well in advance of any improvements of the surface.

In addition to these factors, the surface itself must be prepared by shaping; it should be made uniform, so that the new surface will have uniform support; holes that are more than ¾ inch deep should be patched; and areas that show indication of base failure should be remedied. (J. H. Conzelman says the statement regarding base failure is most important.)

Widening. — This section will refer primarily to widening work involving roads of the macadam type; it will not refer to widening of brick, concrete, or other surfaces that are placed on a concrete base.

In general, the first step in widening is to locate the center line of the completed job. This will determine if both sides are to be widened equally, or not; and it may also determine the necessity for wedge or leveling courses or other operations to correct the crown. In determining the new center line, every opportunity should be taken to improve curvature and alinement.

The next step in widening roads of this type is to dig the trench on one or both sides, as required, and according to the amount of widening. When traffic is using the road, only one side should be opened at a time. To open both sides and attempt to carry on work simultaneously results in practically closing the road to traffic.

The earth along the edge of the road should be carefully broken with a rooter to a depth about 2 inches below the bottom of the old pavement; usually the depth will be 10 to 12 inches. The widening trench should be excavated and shaped by hand, as a rule. In constructing the widened section, details of procedure will follow those for macadam (or other type used). Whenever possible, each layer of the aggregate in the trench should be rolled separately, for which work special trench rollers are available. If not rolled, adequate compaction should be obtained by other means.

The new surface should be brought somewhat above the old surface, so that final rolling will be concentrated on the widened section. Ohio practice is to make the first rolling with the roller backing, the rear outer wheel half on the berm and half on the widened section, and to have the finished new surface slightly higher than the old surface. The heavier rollers should generally be used for this.

If a bituminous surface is desired, as will sometimes be the case, the top or surface course of the widening strips may be of penetration construction, of premixed material, or of road mix. When the latter is used, it may be mixed on the old surface, bladed into position and rolled.

The joint between the new and the old surface may allow the penetration of moisture to the base. For that reason, an adequate surface treatment, or the placing of wedge or leveling courses is often desirable. Where such courses are to be placed, the widened section is sometimes built to the correct contour; but it is generally better to build it of essentially the same grade and section as the old surface, so that the lift of new material will be of about the same thickness over both sections, and will also cover and waterproof the joint between them.

Crown Reduction and Leveling Courses. —Many older surfaces have an excessive crown. Reduction of the crown and leveling of the surface can be accomplished in one operation. Before beginning such work, the section under consideration should be examined carefully to note: 1. If it has the strength to carry the traffic that will come upon it. 2. If the drainage, both surface and subsurface, is adequate. 3. If alinement, sight distance and safety factors are satisfactory.

For crown reduction and leveling, road-mix, hot-mix, or cold-mix materials are used, as may be most convenient. Up to 100 pounds of aggregate per square yard will be necessary for a satisfactory job, normally 50 pounds or more. The compacted thickness will vary from 2 or 3 inches or perhaps more, at the sides and in depressions, to nothing at the center. Prime coats are not needed on bituminous surfaces; otherwise they should generally

This grader is equipped with harrow, blade and roller—three necessary tools for maintenance

be light; and inasmuch as a considerable amount of manipulation of the material may be needed to place the wedge and leveling courses, a slow curing bituminous material is desirable.

When mixing on the job, tamping, leveling and finishing equipment is desirable for the larger jobs. On shorter sections, motor graders and tractor drawn graders are suitable.

Pre-mixed material, asphaltic limestone and rock asphalt also are suitable. If edge depth is considerable, a hot mix may be used, followed by a leveling course of finer aggregate binder, and the standard surface course (JHC). On waterbound macadam, it may pay to build up the wedge courses with macadam and then apply a leveling pre-mix or road-mix surfacing to the entire surface of the road.

Superelevation.— If it is desired to superelevate curves, the same general construction procedure is followed as for wedge courses in crown reduction. First be sure that the value of the old road is such as to merit the work that is planned. Money can easily be wasted, says Perry, on curves that need relocation and on sections that are not heavily traveled.

The amount of superelevation depends upon both the speed of the automobile and the radius of the curve. The speed to be used in establishing superelevation depends on the road; for rural roads it may be 35 miles an hour, but for modern superhighways 70 miles an hour or more. The maximum superelevation used in many places is 1 inch per foot width of road. On a curve of 1000-foot radius (about 5°40′), this will permit a safe speed of 35 miles an hour. In practice, this is about as great a superelevation as should be used, and where curves are of shorter radius, that is, sharper, a slower speed must be used for safety. Highways that are superelevated should also generally be widened.

The center line of the road, when planning for superelevation, may be maintained at uniform grade, the outer edge of the curve raised one-half the superelevation, and the inside edge of the curve depressed the same amount; or the inside edge may be held at the true grade and the outer edge raised the full amount of superelevation; which is preferable will depend largely on local conditions. In some places, raising the outer edge excessively may create a dangerous condition for automobiles running off the edge; in other places, as where grades are flat, depressing the inside of the curve may cause a drainage problem.

The desired superelevation can be built up in almost any way. Macadam construciton is often the most economical, a bituminous surface being added. Any of the materials mentioned as suitable for wedge and leveling courses can be used; however, if superelevation is to be built up 6 to 18 inches, a stable material must be used. It is preferable that the material be subjected to traffic for a sufficient time before laying the surface course to assure thorough compaction. With hot mixes this is not so necessary (JHC).

Shoulders must be built up on superelevated curves so that the normal width is maintained outside of the pavement.

Maintaining Bituminous Surfaces

There are certain procedures, in the maintenance of bituminous surfaces, which with only minor variations are applicable to nearly all types of surfaces. These procedures may include making patch repairs, using hot or cold materials; correcting and smoothing corrugated or wavy surfaces; repair or renewing raveled or broken areas; treating sections that have an excess of bituminous material or that bleed; and skidproofing slippery surfaces.

Surface treatments are also applied to many types of bituminous pavements for the purpose of protecting the wearing surface, smoothing or waterproofing, or for all three purposes; and they are also used for treating gravel or traffic bound roads. The general procedure in application is the same, no matter for what purpose used, though there are variations in preparing the surface, and the selection of the bituminous material to be used will be governed by the type of surface to which it is applied.

Unloading and Heating Tar or Asphalt.—Detailed directions for unloading cars of bituminous materials are contained in several of the handy pocket reference books issued by the tar and asphalt producers. In addition, the following information is given in the Oregon Maintenance Manual:

In making the setup for heating oil and removing it from the tank cars, place the car as far from buildings and other improvements as possible. When the dome cap on the tank car is opened to allow air to enter, move it slightly to one side and cover the opening so that sparks cannot drop into the tank car. This also applies to the truck tank. When heating tank cars, the dome cap should be "cracked" or slightly raised to relieve pressure caused by expansion of material. This also applies to tank trucks. The heating apparatus should be placed on the windward side so that gases from the car will not be blown in the direction of a flame. Require the employees to be very careful about fire and to refrain smoking when near tanks containing hot material, especially those containing cutbacks. Each truck should carry a chemical fire extinguisher (preferably two of them—one in the cab and one on the control platform) and each heating plant should be equipped with three such extinguishers. All boilers that are heated by wood or coal should have spark arresters on the stacks, especially steam rollers.

All cutback materials are inflammable, and special care should be exercised when handling these; they should not be heated to more than 125°F.

Patching.—The work of patching includes the repair of holes, broken areas and depressions. Inspections at regular periods will determine when a surface has broken down sufficiently that holes and broken areas are present. These should be repaired promptly. The presence of depressed areas that trap water is best determined by inspections during or immediately after a rain, while these are clearly outlined by the water standing in them. Depressions should be marked accurately for later repair when the road has dried out.

Comment by A. J. Wiggin: "More care should be given in patching holes in broken surfaces, such as surface treatment and bituminous surfaces. Usually there are sufficient warnings of the weak section to strengthen it before the hole appears. It costs less to prevent a hole than to patch the hole. We have had very good success for the last two years or more by painting lightly the worn places in all types of bituminous surfaces, including some 4700 miles of so-called surface treatment or mixed-in-place.

"This painting is done at all times dur-

ing the winter, down to at least 10° above zero, painting the spots where the surface is worn thin and which in a short time would become a hole. Hot bitumen of the same type of bituminous material used is sprayed lightly by the hand pump at a temperature of 130° to 140° Fahrenheit, and then covered with sand immediately. This painting will be intact until the frost is out in the early spring, thus preventing a hole. We never attempt to do this when the temperature is such that it is warm enough to cause the surface to thaw a little or be damp, but only when it is below freezing and the worn place is dry. Also, we continue to do considerable spot painting during the early spring and after the pavement dries out before the regular treatment is done by distributors.

"In patching a hole that is 2 or 3 inches deep, the hole is filled with very coarse gravel to within 1½ inch of the finished surface. This causes the patch to be only about 1½ inch in thickness, thus saving in mixed patch material. The patch material is mixed in the late summer and stocked in piles. We use a clean material, coarse sand or fine gravel with some stone, not exceeding 1¼" in size, and 14 or 15 gallons of tar, usually viscosity 33 although some viscosity 60. The pile of patch material will be usable for one year, but I have known the material to remain in good condition for 18 months or two years.

"The patch should be stored in a V-shaped pile, 6 or 8 feet in height at the center, and about 10 feet across at the bottom, well compacted on the outside by using a maul or the back of a shovel. The material is covered with sand, about two inches in depth, at the end of each day's work. Now and then the sand should be renewed on acount of heavy rain washing the sand from the pile. This is only a minor cost.

Wheel tractor and graders for maintenance

"During the past few years we have reduced the use of mixed patch by painting the worn place where a hole will appear. Care should be used in patching a hole so that none of the patch will extend over the surface on the outside edges of the hole. We mix very little by hand, using concrete mixers of different sizes."

The general principles of patching were discussed in the first installment of this article. Holes should be cleaned out, cut preferably to a rectangular shape with the edges vertical, and filled with material of the same general nature as that of which the road was originally constructed. Also, compacting and construction of the repair material should follow as closely as possible the methods used in the original con-

When you need special information—consult the *classified* READER'S SERVICE DEPT., pages 50 to 53

A roadside set-up for mixing cold patch (Courtesy Koppers)

struction, so that the repaired area will have the same characteristics. Especial care should be taken that the repaired area is sealed to prevent the entrance of moisture, and that good adherence with the old material is obtained.

The method to be used in patching will be governed by the area, shape and depth of the depression. When a depression or series of depressions are less than an inch in depth, the paint patch is preferable. Depressions of greater depth should be repaired in accordance with the material of which the road is constructed; methods will be discussed under the various types of surfaces.

Paint Patches.—Paint patches are used for correcting minor depressions; also to seal an area that is beginning to ravel, cover lean spots and protect or fill cracks that sometimes form in macadam surfaces, especially in the presence of moisture.

The surface should be carefully cleaned and be free of any loose material. If emulsion is to be used for making the patch, the surface should be slightly moist, but if tar or asphalt is to be employed, it should be dry. Bituminous materials should be properly heated; in general lighter materials are used for checking raveling and heavier ones for building up depressed areas. The bituminous material should be lightly broomed over the entire affected area, or spread with a spray nozzle at the rate of about ⅛ to ¼ gallon per square yard; it is then immediately covered with clean material, screenings or broken stone or gravel with no material over ½ or ¾-inch and rolled. For rolling, the light patching rollers or small tandems are used. According to Perry, paint patches should receive about 10% more cover material than would be given the same amount of bituminous material on surface treatment. An excess of bituminous material interferes with the formation of a bond with the aggregate and results in the displacement of the new aggregate under traffic.

If a single application of bituminous material and aggregate is not enough to fill the depression to the required height, other layers should be added in the same manner. Sealing is generally necessary, especially at the edges using the same binder and slightly smaller aggregate.

In order to get a patch that will be smooth and will conform to the original road surface, care must be taken. The patch area may be laid out by eye or with a straightedge or string. With the latter, the patch can be completely outlined and the depth at any point can be determined.

Patching with Pre-Mixed Material.—When patching with pre-mixed material, the affected area should be cut out to the maximum depth of the depression, or deeper if necessary. The exposed surface should then be painted with cutback or other suitable material; when a dense mixture is used in patching, only the vertical edges of the cut area, unless thinner than ¾ inch, should be painted. (JHC). The patching material is then placed in the hole and, if the hole is small, tamped in layers until it is flush with the surface. If the patch is large, rolling is better. Stockpiled pre-mixed material may be used, or material may be mixed with shovels on a board or in a small concrete mixer. Regardless of the nature of the material used in pre-mixing, patches (except those of low-void material) should be sealed with an application of 1/10 to ⅛ gallon per square yard of bituminous material in order to prevent the entrance of moisture into the hole.

Bleeding Surfaces.—Where bleeding of bituminous surfaces occur, the surface should be covered with coarse, clean sand applied by a mechanical spreader or by hand, if no mechanical spreader is available. Earth should not be bladed in from the shoulders as cover material.

Corrugations.—Corrugating or wrinkling of surfaces may be due to moisture in the mix, to moisture in the base, to the use of an excessive amount of or a too thin bituminous material or to a defective bond between the surface and the base (which also results in disintegration). The first step is to determine the reason for the failure. If it is due to moisture in the base, subdrainage should be installed to remedy this. At times, subdrainage sufficient to correct the trouble can be installed by boring or excavating from the sides. For fuller information, see the section on subdrainage in the February issue.

In the case of surfaces using slow-curing oils, if excess moisture in the mix is the trouble, the surfacing may be scarified, bladed to one side and turned back and forth with blade graders or maintainers until it has dried out. If caused by excessive bituminous material, follow the same procedure in scarifying and work in sufficient new aggregate to give a proper mixture. If lack of bond between the surface and the base, scarify the surface, remove, apply an adequate binder to the base and replace the surface. Planers, surface heaters or disk planers are used to remove corrugations in harder surfaces.

In all cases where the surface is torn up, it must be thoroughly pulverized and remixed before it is again spread, shaped and compacted.

Raveling.—Raveling of a surface is usually caused by an unstable base, insufficient or improper bituminous material, poorly graded aggregate with insufficient fine material, or a combination of these; also sometimes by weathering. This subject will be treated further under road-mix maintenance. The cause of raveling should be determined as the first step. The surface is then scarified, base faults corrected and either bituminous material or bitumious material and fine aggregate, as needed to stabilize the surface, are added. Before respreading the material must be pulverized and thoroughly remixed. After compaction and service under traffic for two weeks or so, a seal coat should be applied.

Surface Treatment

Surface treatment consists of the application, brooming and rolling of bituminous material and mineral aggregate to produce a thin mat or wearing surface, usually less than 1 inch in thickness. This may be an original treatment on a surface not previously treated, or a retreatment. It may be applied hot or cold and the size and character of the aggregate may be varied to meet the objects for which the surface was planned, as for renewal of waterproofing, or to add structural strength.

In most cases the surface treatment is used for waterproofing, preventing dust, or providing a wearing coat, or for all three. It cannot be relied on to carry traffic loads except when it rests on a firm and stable base. Therefore adequate drainage and preparation of the roadbed is a necessary preliminary to successful surface treatment.

Surface treatment application may be to already treated or surfaced roads, in which case the treatment may be light to renew waterproofing and smooth the surface, or heavy to accomplish these objectives and also to provide added depth of surfacing; or to untreated surfaces, of which there are two classes—those with tightly bonded surfaces, such as waterbound macadam, clay-gravel, sand-clay, limerock, concrete, brick, etc.; and unbonded surfaces, as traffic bound macadam, sandy gravel, cinders, etc.

The success of surface treatments de-

pends upon very careful attention to certain details, which include:

1. Careful cleaning of tightly bonded surfaces, well beyond the limits to be treated, so there will be no dust under the edge. Mechanical sweepers and sweeper-blower units are best for this purpose, supplemented by hand sweeping for depression and holes.

2. Adequate priming of the original road surface with bituminous material of proper viscosity to obtain necessary penetration, hardening, consolidation and bonding.

3. Uniform, unbroken and accurate distribution of the bituminous material by means of pressure distributors.

4. Uniform application of aggregate, the use of mechanical spreaders being a practical necessity.

5. Light rolling by 3-wheel or tandem rollers of properly balanced design, sufficient only to imbed the aggregates and not to crush them.

The procedure employed in the construction of surface treatments will vary slightly with local conditions and with the materials used. In general, details should follow the recommendations of the company furnishing the bituminous material. Equipment needed includes a bituminous distributor, sweeper, chip spreader, broom drag and roller. If the job is large, more than one of each will be needed.

The surface, which should have been previously prepared by draining, patching and shaping, is swept and then

A sander for surface treatment

primed, using 0.3 to 0.5 gal. per sq. yd. of a penetrating tar or asphalt. No cover should be placed unless required for traffic protection. Allow this to penetrate and the surface to become reasonably dry. A. R. Taylor of Koppers states: Personally I prefer to see the second application spread on the prime coat within 3 days after application of prime. Prime well, then slightly reduce heavy material in second application, which gives a better bond to road surface. G. R. Christie, Standard Oil of N. Y., says: Then apply 0.25 to 0.40 gal. per sq. yd. of a binder, covering this application at once with 25 to 40 pounds per sq. yd. of ½-inch to ¾-inch aggregate. (GEM recommends ⅜-inch to No. 8). Roll this once over, immediately following the application of the aggregate. Then broom drag and roll. When using hot bituminous material, slightly larger applications—0.4 to 0.6 gal. per sq. yd. — are used and covered with 45 to 65 pounds of aggregate slightly coarser than that given above. Double and triple surface treatments, using up to 0.6 and 0.8 gal. bituminous material per sq. yd., and cover material graded down to fine sizes for the last application are also used.

On loose surfaces, the procedure is varied slightly. A lighter prime is generally used as there is more fine material in the surface, but successful use of RT-4 is reported (ART). The second application may be the same as the first. For retreatments, the procedure may also vary slightly, depending on the type of surface to which the treatment is applied. Further information will be given in connection with each type of surface.

When applying cover material, give consideration to traffic requirements. When operating trucks or spreaders against traffic, flagmen should be posted to safeguard traffic.

Types of Surface Treatment.—Surface treatments may be plain or dragged. On the lighter treatments, where less than 0.4 gallon per sq. yd. of tar or asphalt and 35 to 45 pounds of aggregate are used, dragging is not generally desirable. Dragged treatments are best when 0.5 gal. per sq. yd. of bituminous material and 50 to 60 pounds of aggregate are used. About one-fourth of the aggregate should be applied after dragging **and before rolling.**

For dragged treatments, aggregates

should be relatively free from fines in order to assure complete penetration of the bituminous material; otherwise pockets containing fine material may not receive an adequate amount of binder. The steps in procedure are: Priming, if necessary; spreading and smoothing of 75% of the aggregate to be used, that is 40 or 45 pounds per square yard; applying bituminous material; dragging with a long-base drag; spreading of the remaining aggregate; rolling. The two final steps should follow without delay. A light seal coat is desirable. In general, the bituminous material should be the heaviest that the air conditions and the type of aggregate will permit, and it is preferable to heat the bituminous material, excepting the primer.

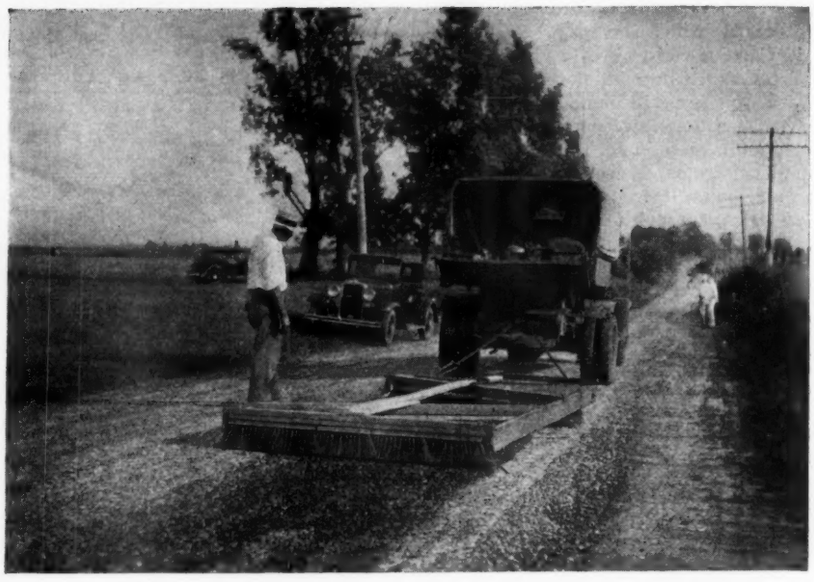
If the surface to be treated is rough and corrugated, Connecticut advises delaying dragging to allow the bituminous material to penetrate the existing surface mat, but on smooth surfaces to start dragging almost immediately after application of the tar or asphalt. When hot material is used, dragging should start immediately; with cold material it may be delayed. Dragging may start at the center or at the edge, depending on whether it is desired to build up or flatten the crown. Except in emergencies, dragging should not be done against traffic, but if this is necessary, proper traffic guards should be posted. Drags should not be turned on the right-of-way unless guards are placed to protect traffic properly. Workmen should not be allowed to ride on drags or hones at any time; when weight is required, stones, sand bags or other like materials should be used.

Advantages of Surface Treatment.—The advantages of surface treatments include the following: They produce a uniform appearance over the entire road surface, as contrasted to treatment by patching. In connection with wedge courses for crown reduction, surface treatments give, also, a smooth and uniform surface, covering any irregularities in finish or appearance resulting from the wedge courses, and also provide a water-proofing of the entire surface. They may be used for producing a non-skid surface on slippery pavements; and at the same time waterproof the surface and provide a dustless wearing course.

The Use of Tar in Surface Treatment.—All of the various grades of tar have been used for surface treatments. The tendency, however, is to use the heavier materials. The exact choice will depend upon the character and type of surface to be treated and the climatic and weather conditions existing where the work is to be done.

Tars are used in the surface treatment of all types of roadway surfaces. In general, the lighter grades of tar are used for prime coats, the medium grades for the treatment of gravel and macadam surfaces, and the heavier grades for the surface treatment of road mixes, plant mixes, concrete and brick. Tar treatments are used to correct slippery conditions on various types of surfaces.

The general methods of application previously described are satisfactory for tars. (By G. E. Martin).



A broom drag for leveling operations on light surface treatment

Asphalts in Suface Treatment.—A variety of asphalt products are used according to needs of the particular location and aggregate available. For original heavy treatment, MC-1 is employed as a primer at rate of ¼ to ½ gal. per sq. yd. Hot asphalt cement (150-200 pen.) is then applied at rate of 0.4 to 0.5 gal. per sq. yd. and covered with crushed aggregate, 40-60 lbs. For retreatments or seal coats RC-1 or RC-2 cutback asphalt is usually employed, at a rate of ¼ gal. per sq. yd. and covered with 25 lbs. of crushed aggregate. For very light treatments both RC-1 and MC-2 cutback asphalts at the rate of 0.1 to 0.2 gal. per sq. yd. are employed and the cover aggregate may be sand or fine crushed aggregate. If aggregates are dusty or porous, the use of MC cutback asphalts are recommended. MC-5 cutback asphalt is being increasingly used for heavy treatments. (B. E. Gray.)

Maintenance of Surface Treatments

The surface treatment mat is thin, and any breaks in it require prompt repairs in order to prevent them from spreading. Moreover, breaks permit the entrance of surface water which may considerably increase the area that must be repaired. Therefore the patrol system of maintenance, which insures prompt attention to repair needs is desirable for this type of surface.

A heating kettle, with spray nozzles, small tools and a light truck equipped to carry two sizes of aggregate are the minimum essential tools for patrol maintenance. The kettle may be of any size from 50 to 150 gallons capacity. A small mixer for making pre-mixed material, or a supply of this already mixed at a convenient point is desirable.

Pre-mixed material is generally preferable for small patches. The details of preparing the area and of placing the patches have already been described.

Maintenance of proper drainage is perhaps the most important step in the maintenance of surface treatments. The needs for both surface and subsurface drainage should be studied carefully and every break should be considered in relation to the possible lack of adequate drainage.

Maintenance by Retreatment. — The principal maintenance procedure with surface treated roads, however, consists of periodic light retreatments. The procedure already outlined should be followed, except that lighter applications should generally be used on retreatments, that is, 0.20 to 0.35 gal. per sq. yd. of bituminous material and 20 to 30 pounds per sq. yd. of aggregate. The same operations should be followed as for original treatment. The period between treatments will usually be two or three years. Retreatments should not be too heavy, nor be given until they are needed. The general tendency is to give a heavier retreatment than is necessary, and also to give it before it is really necessary to do so. One engineer follows this rule: That when he is thoroughly satisfied that the surface must be retreated, he delays retreatment one more year. A mat that is too heavy will tend to "push" under traffic.

Maintenance with Rock Asphalt and Premixed Material.—In the past few years the use of a pre-mixed bituminous material and rock asphalts for retreating surface treatment has been increasing. The premixed material in the case of the rock asphalt may be used as a very thin seal—16 to 40 lbs. per sq. yd.—or 50 to 75 lbs. may be used if the condition of the old surface or traffic requirements make the larger amount necessary. The very thin seal coats—either limestone or sandstone rock asphalt—are spread by motor patrol on the tack coated old surface. From 0.05 to 0.15 gal. of cutback per sq. yd. is used depending on the density of the old surface. The larger quantities of premixed material may be spread by mechanical

spreaders or motor patrols. Rock asphalts spread by motor patrol should be wasted out thinly under the blade and the surface built up gradually. The surfaces are improved by rolling continuously behind the grader as the surface is built up. A smooth, thoroughly compacted riding surface that does not show the irregularities in the old surface when subjected to traffic can be secured in this manner (J. H. Conzelman).

Traffic Control. — Surface treatments and retreatments are almost invariably placed on roads that are in use. Traffic often cannot be detoured. Therefore provision to care for traffic during treatment must be made. A barricade and sign should be erected at each end of the section to be treated; one-half of the road is then treated, while traffic uses the other half. Because the passage of an automobile at speeds greater than about 25 m.p.h. over the unfinished surface treatment at certain stages during the construction process results in probably permanent damage, traffic should pass through the one-way section under control in order to prevent the faster drivers from passing slower vehicles by driving on the partly completed work.

Maintenance of Concrete Pavements

Surface maintenance of concrete pavements consists of repairing breaks, mudjacking, leveling, checking disintegration, sealing cracks and joints, reducing slippery conditions and finally resurfacing. The first maintenance that is needed by a concrete surface is to seal the core holes left by the testing crew, using the standard concrete mixture used in the pavement.

In general, the necessity for extensive maintenance work on old sections must be weighed against possible early replacement or reconstruction. This section will be primarily restricted to information on day to day maintenance work, not including reconstruction.

Removing High Spots.—The area to be cut down should first be determined by using a straight-edge, marking the high spots. In general, cutting down of high spots should be confined to those not more than 2 inches high; if a greater amount must be removed, it is better to take out a section of the slab and replace it. For shallow cuts, a mason's chipping chisel may be used first, followed by a bush hammer. For heavier work, an air hammer or a grinder should be used. Care must be exercised not to break the pavement, and to leave the finished surface in a smooth condition. A straight edge should be used for checking. It does no damage to cut into the coarse aggregate.

Correcting Low Slabs.—The mudjack is the best tool for raising sunken slabs. Patches of bituminous material are suitable temporary repairs, but are unsightly. The first step in preparing for mudjacking, is to determine if there is sufficient space between the adjacent slabs to allow raising; if not a relief cut two or three inches wide must be made so that the slabs can be raised freely. In making this cut a pavement breaker is generally used, and the opening is made by working from both edges toward the middle, which procedure reduces the liability of cracking the slab. After the necessary cuts have been made, holes are drilled in the slabs for jacking. These are about 2⅜ inches in diameter. Spacing depends upon the judgment of the operator as to the location necessary to obtain an even raising of the slab. Perry suggests that the holes be located at the points that would be used if ordinary mechanical jacks were being employed for lifting.

The material or "mud" used for jacking is a mixture of clay, sand and portland cement. The amount of clay should run from 25% to 40%; the amount of silt about the same; the sand not more than 20%; and portland cement about 5%. It is best to have advice from the state highway department unless experienced in this work.

In raising the pavement, first application should be made in the lowest hole; thereafter, application should be made in relatively small amounts at each of the holes to bring the surface to the proper grade smoothly and uniformly. Too much filler in one place will result in an uneven rise, and a crack may develop in the pavement. If leakage of the mud should occur at the sides of the pavement, pumping

Steps in repairing concrete pavements. Top, left to right: Cutting the hole, the hole, and tamping. Below, smoothing, testing, and crack pouring

should be stopped for about 45 minutes, during which time the mud will set up and seal the leak, after which pumping can be resumed. The holes, after repair has been completed, should be filled with mud, but not with concrete or bituminous material, in case they may need to be used again. If there is a gap between adjacent slabs after jacking, this may be filled with concrete or bituminous material.

Breaks or Failures.—Breaks are classified as either traffic failures or blow-ups. In repairing, all of the broken area should be removed, the edges trued up and cut back to firm material; and the subgrade excavated back under the original firm concrete. High-early-strength cement, or a rich mixture of concrete should be used for repairs. This should be mixed with as little water as possible, carefully tamped in place, and carefully straight-edged and belted. Note also the information hereafter regarding placing patches.

Where the failure extends across the whole width of the pavement, a transverse joint may be necessary or desirable. Exceeding care should be taken to construct this at right angles to the center line of the pavement, and vertical. When working on a repair job of this type, every effort should be made by the foreman or supervisor to determine the cause of failure; and in repairing the surface, the cause of the original damage should be eliminated if possible.

When breaks occur within about 10 feet of an expansion joint, it is usually best to remove all the concrete between the break and the expansion joint and replace it. If the pavement is reinforced (as will usually be the case) the edges of the concrete should be broken back on all sides until at least 50 times the diameter of the reinforcement is exposed. That is, if the reinforcing is ¼ inch, the concrete should be removed so as to expose ¼ x 50, or 12½ inches of reinforcing. Exposed reinforcing should be thoroughly cleaned of rust, scale and adhering concrete. Concrete pavements replaced over excavations should be reinforced for the full area of the repair, whether or not the original pavement is reinforced. Concrete should be placed on a moist subgrade that has been thoroughly compacted and brought to the proper grade and section. Protect the repaired area against traffic and allow to cure thoroughly.

Patching.—Holes more than an inch deep, says the Portland Cement Association, should be patched with concrete; holes should be dug out to a depth of at least 2 inches and deeper if necessary to remove all unsound concrete. Edges should be trimmed with a cold chisel to make a vertical, square edge for a depth of at least an inch below the surface of the old old pavement but below that depth should be rough. All dirt, dust and other loose material should be removed from the hole and the sides and bottom of the hole wetted, but no water should be left standing in the hole. The hole is filled with freshly mixed concrete, which is tamped firmly against the sides and bottom. At intervals of five to ten minutes, as the concrete dries out or sets, repeat the tamping. This tamping should be done at least three times, the interval between the tampings depending upon the temperature and the rapidity of set. After tamping, strike off the patch with a straight edge and finish carefully with a wooden hand float. The hole should be a little overfull at first to allow for compaction by tamping.

Calcium chloride, high-early-strength cement, or a rich mixture of ordinary portland cement should be used for the patch. Mix very dry—about 4 gallons of water per bag of cement.

If a dry concrete is used, and the tamping and finishing procedure outlined above is followed, the connection between the new and the old concrete will be scarcely visible. Concrete shrinks slightly as it hardens, and this shrinkage must be taken care of by tamping while the concrete is hardening; otherwise a fine crack will appear at the junction of the new and the old concrete.

Shallow Patches.—For holes that are less than an inch in depth, the Portland Cement Association recommends the following procedure: Clean all dirt and loose material from the area; be sure that the concrete is dry, then paint the area with a thin coat of bitumen. Using coarse dry sand or crushed stone screenings, mix with bitumen, using just enough to coat every particle; too much bitumen is undesirable. Tamp this mixture firmly into the depression and smooth off the surface to conform to the adjoining pavement. Then paint the surface of the patch with a thin coat of bitumen and cover immediately with sand or screenings.

To repair very small holes, such as those caused by a clay ball, bit of wood, or other foreign material in the concrete, fill the hole with bitumen and cover with sand.

Patching Scaled Pavement with Cement Mortar.—The following method of patching scaled concrete pavements has been reported by the Bureau of Public Roads as being used with success in Massachusetts: All disintegrated concrete in the area to be patched is removed with a chipping hammer. The area is then cleaned with a 50% diluted solution of muriatic acid, using a stiff brush, following which it is washed carefully with water, brushed out and allowed to dry. After drying, the area is painted with cement mortar and brought up to grade with a 1-1½-3 mixture of cement and small aggregate, using a very low water content. The patched area is then thoroughly compressed by rolling with a tandem roller, and protected for seven days before traffic is allowed. This method of patching was reported as blending well with the old surface and being very satisfactory.

Joints and Cracks.—Cracks and joints should not be filled when the surfaces are wet; when dry they should be cleaned out thoroughly with a sharp-pointed metal tool and a stiff brush or broom to remove all loose particle and dirt. A blower is very desirable to obtain complete cleaning, especially on narrow cracks. Sometimes a hose attached to the exhaust pipe of the maintenance truck will be sufficient. When the crack or joint is thoroughly clean, it should be filled with tar or asphalt. No more bituminous material should be used than enough to fill the opening, and the least possible amount of cover material should be used. If the bituminous material dries and hardens quickly, no cover need to be used. When using a hot filler, care should be taken not to overheat or burn the material. A thermometer should be part of the equipment of every heating kettle.

Succeeding installments will cover maintenance of macadam, stabilized soil, bituminous and cement stabilized, hot and cold mix, road mix and brick

In sealing center line joints, special care should be taken to permit neat center line markings, if these are to be used.

Small cracks need to be sealed only about once a year, generally in the fall, but wide cracks should be sealed often enough to prevent damage from impact, using mastic or pre-mix material.

Preventing High Joints.—While the prevention of high joints in concrete pavements is primarily a function of the care in preparing the base and constructing the pavement, the swelling of certain types of plastic subgrade soils may cause warping of the pavement slabs. In experimental work in Minnesota, it was found that this warping can be prevented by the use of specially sealed joints, or by the use of granular base courses at least 9 inches deep. The latter is not a function of maintenance operations, but proper joint sealing to keep the moisture from contact with these plastic soils will also prevent most or all of the high joint troubles. Experience indicates that cracks and joints should be sealed in the fall instead of in the winter, and that a soft asphalt filler is superior to a hard asphalt filler. Best results were obtained with an asphalt having a penetration of 80 to 100 at 25°C, with an admixture of celite of 25% by weight.

Patching with Cement Bound Macadam.—Kansas has a patching unit, which uses cement bound macadam for repairing holes in concrete pavements. The concrete in the broken area is removed and also the subgrade for a depth of 4 inches, and back under the slab about 4 inches also. The hole is cleaned with compressed air; that part of the broken concrete that is suitable is placed in the hole and tamped; then 1 to 2½-inch broken stone is used to fill the hole, generally to about ½ inch above the existing surface.

This aggregate is then sprinkled with water to facilitate grout penetration; grout is mixed in a concrete mixer, using a 1:2 mix and 2½ gals. of water per sack of cement. The grouted patch is then tamped into place. Final tamping is delayed 30 to 60 minutes—as long as will permit leveling the patch to the surface and flushing mortar to the top for the final finish. This delayed consolidation reduces shrinkage of the patch.

Final finish is with a wood float. The patch is then cured under a double thickness of wet burlap for about 16 hours before opened to traffic.

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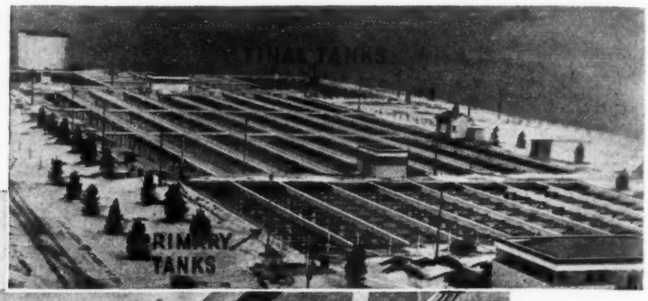

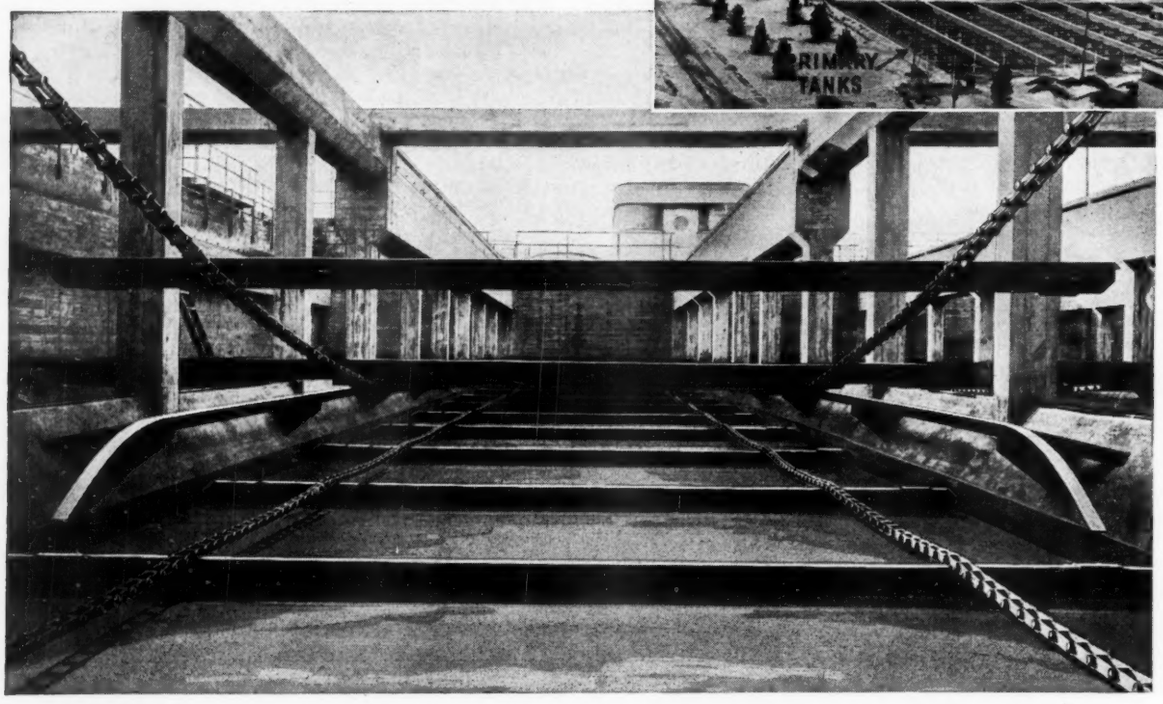

STRAIGHTLINE Longitudinal Collectors in final tank. Insert: General view of Tallman's Island Sewage Treatment Plant, showing primary tanks in foreground and final tanks in background.

● The engineers, New York City Department of Public Works, for Tallman's Island New York World's Fair Sewage Disposal Plant (activated sludge), like the engineers on many other large and small sewage plants throughout the country, selected Link-Belt **STRAIGHTLINE** Collectors for the primary and final settling tanks because of their proved reliability.

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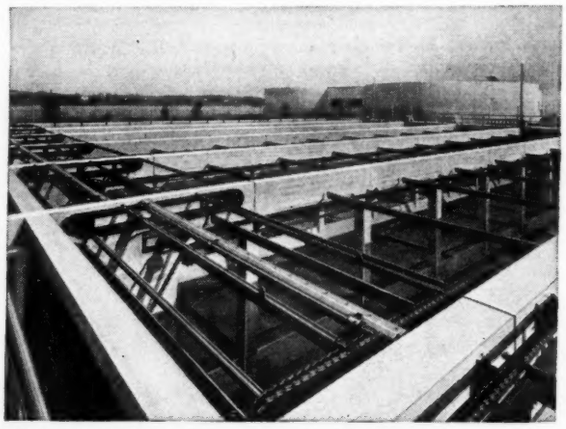

Effluent end of primary tanks, showing longitudinal collectors and skimming collectors.

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When you need special information—consult the *classified* READER'S SERVICE DEPT., pages 50 to 53

Building Grades to Reduce Snow Removal Costs

(Continued from page 23)

slope from this point to the shoulder of a grade with a top width of 20 ft. This makes a grade surface slightly higher than the regular 24 ft. grade and consequently the snow banks do not give trouble until later in the season. This type of grade is very cheaply rolled up but is limited to level terrain and light traffic requirements.

Wherever we build a new road or relocate an old one so that a new right of way must be acquired, we make the new right of way six rods wide. This enables us to build a grade with a 24 ft. top, 4 on 1 shoulder slope to a ditch depth of 3 ft. and a ditch bottom width of 8 ft. and the customary back slope of 2 on 1, which elevates the grade surface to a point where the snow removal problem becomes practically nil.

I believe that in a large percentage of the counties where the ordinary snow removal problems obtain it will be found that the first described type of grade will be found very satisfactory. Special conditions will of course require modifications of design. We hope that the above will serve to point the way for some of the other localities which have snow removal problems similar to our own.

In closing I remark that we have been gradually improving our tough miles, as above, for the last five years and find a marked decrease in snow costs in every case. Last year we did not hesitate to bury a mile of stone road, and this year are saving at least $400 in snow removal cost upon that particular mile.

Effects of Vibration of Concrete

A SUB-COMMITTEE on Vibrated Concrete of the (British) Institution of Civil Engineers is conducting tests on the effects of vibration on concrete, and has recently submitted a second interim report. This includes concretes with mixes ranging from 1:3 to 1:9 by weight. The investigation included study of the effect of vibration on concrete strength, creep, shrinkage, and extensibility, as well as of the bond between concrete and reinforcement. The following conclusions are drawn, it being emphasised that these apply only to the concretes used in the tests and may require revision for larger masses of concrete and different types of vibration.

(1) The grading of the aggregate does not affect the strength of vibrated concrete, with a particular water/cement ratio, when the vibration is sufficient for satisfactory consolidation of the concrete. The grading is of less importance for mixes richer than 1:6 (by weight) than for leaner mixes. The use of a 1:9 mix requires careful consideration and tests to determine a suitable grading.

(2) For mix proportions of from 1:3 to 1:9 (by weight) and water/cement ratios of between 0.275 and 0.65, the relationship between water/cement ratio and the optimum strength obtainable with the present type of variation is practically linear.

(3) In some cases the use of a very rich mix with a particular water/cement ratio may lead to a lower strength than a leaner mix with the same water/cement ratio. This applies when the water content is such that the use of the richer mix leads to a very wet concrete.

(4) Strengths adequate for many practical purposes can be obtained with a vibrated 1:9 mix (by weight) with a comparatively low water content, when a suitable grading is used.

(5) The effect of prolonged vibration of a wet mix is to throw out excessive water and to leave a concrete with a water/cement ratio less than the nominal value. This results in increased strength; a higher strength would, however, be obtained by vibrating for a short time a mix whose water/cement ratio is equal to the value obtained with the wetter mix after prolonged vibration.

(6) There appears to be no important effect on the strength of concrete if it is subjected to short-period vibration subsequent to the initial vibration used for compacting it.

(7) Both the shrinkage and creep of concrete are reduced by using lower water contents and compacting by vibration; the modulus of elasticity and the modulus of rupture are at the same time increased.

(8) The bond between concrete and steel is improved by using a lower water content and compacting by vibration.

(9) The extensibility of vibrated concrete is apparently not less than that of hand-compacted concrete.

It is thought that the work so far carried out has shown that the use of vibration as a means of compacting concrete allows a lower water/cement ratio than would be possible for hand-tamped concrete; and that the physical properties of vibrated concrete differ from those of hand-tamped concrete only in so far as they are affected by the change in water/cement ratio.—From *Road Abstracts.*

Cement-Sawdust Concrete

Cement-sawdust concrete is composed of a mixture of Portland cement, sawdust and water. The general appearance is the same as an ordinary cement-sand mortar except that it is light and fluffy. The finished product will vary in weight and surface texture according to the proportions, an average weight being about 45 pounds per cubic foot, or about one-third that of ordinary concrete.

The compressive strength of the material will also vary with the proportion of cement to sawdust, but will average 300 to 400 pounds per square inch.

The material is warm and is an excellent insulating agent. The coefficient of thermal conductivity varies from 0.60 to 0.70 for most mixture proportions.

The finished product is water repellent, easily finished to a smooth surface, relatively resistant to abrasion and fire resistant, and will not support combustion; tests prove that it will withstand temperatures up to 250° F. without detrimental effects.

Another desirable quality of the material is the ease with which it can be cut after it has hardened. It can be sawed with an ordinary carpenter saw and it will hold nails or screws. These qualities indicate the possibilities of its use where precast units may be fitted around pipes and timbers and into special places.

The sawdust should be of that quality obtained from the main saw, rather coarse in size and not less than one year old. White pine, spruce or hemlock sawdust is preferable. Hardwood sawdust is not recommended since the grains are likely to be too small and too uniform in size. Sawdust obtained from a resaw, or from factories or mills should never be used because the grains are too small.

The sawdust should be screened through an ordinary mason screen, in order to remove the larger pieces of stringy bark. The mesh of the screen should not be less than one-fourth inch.

Readers' Service Department

These helpful booklets are FREE. Write to the firm whose name is given, mentioning PUBLIC WORKS, or to this magazine.

Construction Materials and Equipment

Air Compressor from Ford Parts

5. How you can convert an ordinary Ford model A or B motor into an air compressor for operating jackhammers, paving breakers, clay spaders, tampers, paint sprays, etc., is explained in a new bulletin just issued by Gordon Smith & Co., Desk G, 516—10th St., Bowling Green, Ky.

Concrete Accelerators

30. "How to Cure Concrete," a forty-seven page manual published by the Dow Chemical Company, Midland, Michigan, treats fully subject suggested by title.

36. "Wyandotte Calcium Chloride and its use in Portland Cement Concrete," a booklet covering the subject of curing concrete pavements, structures, etc., giving complete specifications for surface and integral curing. Published by the Michigan Alkali Co., 60 East 42d St., New York, N. Y.

Concrete Mixers

44. Catalog and prices of Concrete Mixers, both Tilting and Non-Tilt types, from 3½S to 56S sizes. The Jaeger Machine Company, 400 Dublin Ave., Columbus, Ohio.

Dirt Moving Efficiency

65. "Dirt Moving," is a new 32 page booklet illustrating the use of Trac Tractors as a source of money-making power for bulldozers, bullgraders, wheel scrapers, fresnos, graders, dump wagons, tampers, etc. 24 pages of action pictures, directions, etc. Sent promptly by International Harvester Co., 180 No. Michigan Ave., Chicago, Ill.

66. Where loading is done by hand, the Load Lugger, with your small truck, will cut costs tremendously. Simple, low in price. Especially adapted to city, county and town work. Complete details on request. Brooks Equipment & Mfg. Co., 56 Davenport Road, Knoxville, Tenn.

67. "Modern Methods of Moving Earth" is an 88-page illustrated book explaining earth moving by tractor power. Tells what types of equipment is most efficient for each class of work and includes estimated costs of the different methods on average jobs, short cuts in estimaing, etc. Sent only to those having earth moving problems by Cleveland Tractor Co., 19,300 Euclid Ave., Cleveland, Ohio.

Drainage Products

70. Standard corrugated pipe, perforated pipe and MULTI PLATE pipe and arches—for culverts, sewers, subdrains, cattlepasses and other uses are described in a 48-page catalog entitled "ARMCO Drainage Products," issued by the Armco Culvert Mfrs. Association, Middletown, Ohio, and its associated member companies. Ask for Catalog No. 12.

Finisher

78. A very complete, 36 page illustrated booklet on the Barber-Greene Tamping-Leveling Finisher explains its important features, principles of operation, types of jobs it handles and materials laid. Ask for catalog 879, Barber-Greene Co., 635 West Park Ave., Aurora, Ill.

Hose and Belting

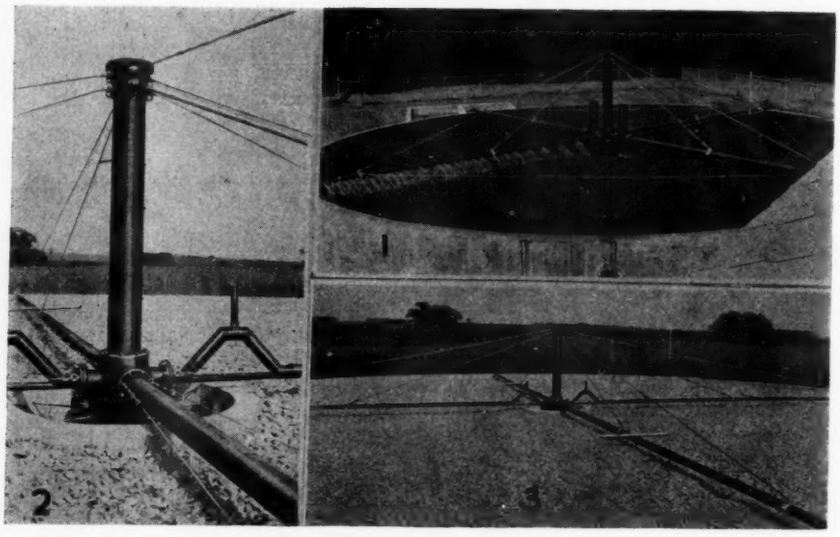
87. Complete information on rubber hose and belting for all types of contracting and road building service. The Government Sales Department of the Goodyear Tire & Rubber Co., Inc., Akron, Ohio.

Mud-Jack Method

107. How the Mud-Jack Method for raising concrete curb, gutter, walls and street solves problems of that kind quick-

(Continued on page 51)

Keeping Up With New Equipment



PFT rotary distributor installations

"Double Flow" Rotary Distributors

It is now possible to secure the maximum range of flow while operating under a minimum differential of head with P.F.T. "Double Flow" rotary distributors. This principle makes it possible to secure successful operation with ranges of flow such that the maximum may be as great as 500% of the minimum flow with approximately the same variation in head as is practical for the conventional type of distributor.

The increased range of flow is secured by operating the distributor as a 2-arm unit at low flows with automatic controls, causing the other two arms to come into service at a pre-determined rate of flow to allow more distribution jets to discharge, thereby requiring a lower head to discharge a given quantity of sewage for maximum flow conditions.

Fig. 1 shows original type installed as Metuchen, N. J. The new arrangement is shown in Figures 2 and 3 (Belle Plaine, Iowa).

New Caterpillar 25-HP Tractor

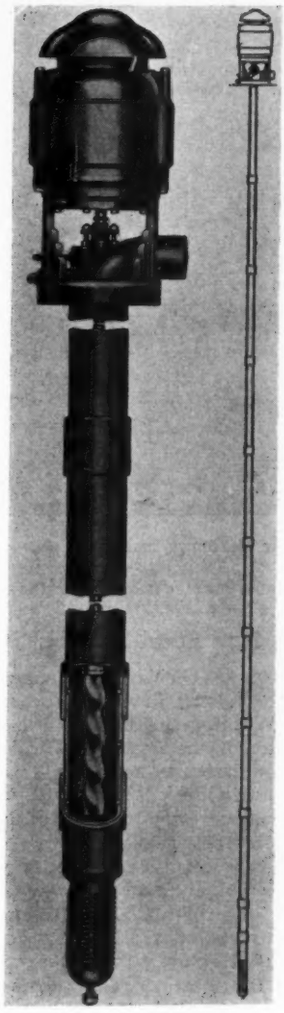
A new 25-horsepower tractor, the R2, has been announced by Caterpillar Tractor Co., Peoria, Illinois. This tractor features an engine with optional fuel systems—high compression for burning gasoline, moderate for using various grades of tractor fuels. A five-speed transmission has been provided to give correct working speed for every type of job that the machine will encounter.

The R2 will handle blade graders designed for tractors of approximately 25-horsepower. In addition, it will pull smaller maintenance machines, terracers, rollover scrapers and similar loads. In agricultural work, the new tractor will, under average conditions, pull a three or a four-bottom 14" plow, a three base lister, ten foot double disk harrow, 12 to 16 foot engine driven combine, and similar loads.

New Caterpillar 25 hp. R-2 tractor

New Peerless Pump for Small Drilled Deep Wells

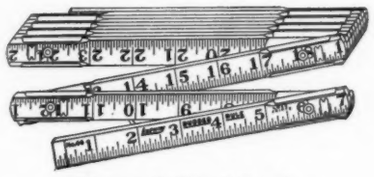
"Hi-Lift" is the trade name given a new pump made by Peerless. This pump is said to have unusual ability to obtain the maximum capacity from small drilled deep wells (as small as 3" in diameter) with lifts ranging from 40 feet to 1,000 feet and with small variation in capacity, or pressure, regardless of the height of lift. Other features are simplified design, slow speed operation of 1760 r.p.m. and unusual resistance to abrasion. Capacities start at 5 gallons per minute, and pressures in excess of 500 pounds are obtainable. Literature available from the Peerless Pump Division, Department 172, 301 West Avenue 26, Los Angeles, Calif.



Peerless "Hi-Lift"

Lufkin Rugged Rule

This is an extra sturdy six foot folding rule of tough hardwood, with sections of extra thickness, making it not only more durable but more rigid than ordinary rules. It has brass strike plates, preventing wear of sections in opening and closing. The sections have a special finish, giving them a uniform, light, boxwood color, so the black markings are easy to read. Lufkin Rule Co., Saginaw, Mich.



The new Lufkin 6 ft. rule

This is the Jeffrey "Waytrol" feeder, dressed up in a streamlined metal sheath. The feeder is of the electric vibrating type, and will handle any dry chemical. Case is dustproof. Styling by Harold Van Doren and Associates, Toledo, Ohio.

Readers' Service Department

These helpful booklets are FREE. Write to the firm whose name is given, mentioning PUBLIC WORKS, or to this magazine.

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ly and economically without the usual cost of time-consuming reconstruction activities—a new bulletin by Koehring Company, 3026 West Concordia Ave., Milwaukee, Wis.

Paving Materials, Brick

116. Standard specifications for vitrified brick pavements and brick parking strips and gutters, as adopted by the American Society of Municipal Engineers. Also standard specifications for bituminous filled brick pavements adopted by the American Association of State Highway officials. If you contemplate using brick for paving, you should have a set. National Paving Brick Ass'n, Washington, D. C.

Pumps

121. New illustrated catalog and prices of Jaeger Sure Prime Pumps, 2" to 10" sizes, 7000 to 220,000 G.P.H. capacities, also Jetting, Caisson, Road Pumps, recently issued by The Jaeger Machine Company, 400 Dublin Ave., Columbus, Ohio.

123. New brochure by Gorman-Rupp Co., Mansfield, Ohio, illustrates and describes many of the pumps in their complete line. Covers heavy duty and standard duty self-priming centrifugals, jetting pumps, well point pumps, triplex road pumps and the lightweight pumps.

124. 16-page illustrated bulletin, SP-37, describes and illustrates complete C. H. & E. line of self-priming centrifugal pumps from 1½" to 8", including lightweight models for easy portability. C. H. & E. Mfg. Co., 3841 No. Palmer St., Milwaukee, Wis.

Road Building and Maintenace

126. See road work as it was done in the 1890's and as it can be done by a full line of this year's road building equipment. See, in this new action picture book, the first reversible roller, 1893 World's Fair Award Grader and how methods have changed. Attractive new booklet AD-1796 recently issued by The Austin-Western Road Machinery Co., Aurora, Ill.

127. Motor Patrol Graders for road maintenance, road widening and road building, a complete line offering choice of weight, power, final drive and special equipment to exactly fit the job. Action pictures and full details are in catalog 200 issued by Galion Iron Works & Mfg. Co., Galion, Ohio.

Rollers

130. New bulletin describing in detail the new Huber Road Rollers will be sent promptly on request by the Huber Mfg. Co., Marion, Ohio.

132. "The Buffalo-Springfield line of road rollers (tandem, 3-wheel, and 3-axle) are described in the latest catalog issued by the Buffalo-Springfield Roller Co., Springfield, Ohio."

Shovels, Cranes and Excavators

145. The Austin-Western-Badger, a fully convertible ½ yard crawler shovel, made by The Austin-Western Road Machinery Co., No. A-5 Aurora, Ill., is fully described and illustrated in their Bulletin No. AD-1683.

146. New catalog picturing the detailed construction of Osgood "Chief" power shovel and illustrating it as shovel, clamshell, dragline, crane and piledriver. Write The Osgood Co., Marion, Ohio, for your copy.

Soil Stabilization

150. "High-Service, Low Cost Roads" is one of the newer booklets using an effective combination of picture and text to set forth the principles and advantages of road surface stabilization with calcium chloride. Complete, interesting and well illustrated. 34 pages. Sent by Solvay Sales Corp., 40 Rector St., New York, N. Y.

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Readers' Service Department

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Street and Paving Maintenance

Asphalt Heaters

198. Illustrated Bulletins 15 to 20 describe Mohawk Oil Burning Torches; "Hotstuf" Tar and Asphalt Heaters; Portable Trailer Tool Boxes; Pouring Pots and other equipment for street and highway maintenance, roofing, pipe coating, water proofing, etc. Mohawk Asphalt Heater Co., Frankfort, N. Y.

Bituminous Materials

202. The maintenance of all types of roads and streets is the subject of this 52 page booklet which will be sent on request by The Barrett Co., 40 Rector Street, New York, N. Y.

Dust Control

210. "How to Maintain Roads with Dowflake" is a new 58 page illustrated booklet of information on stabilized road construction. Includes specifications and several pages of reference tables from an engineer's notebook. Issued by Dow Chemical Co., Midland. Mich.

211. A complete booklet on dust control titled, "Dust Control and Road Stabilization," describes the use of Columbia Calcium Chloride for dust control purposes and stabilization of roads. Sent on request by The Columbia Alkali Corp., Barberton, Ohio.

Pouring Pots

265. Full line of welded, screened and hooded pots, light, strong and accurately balanced, designed for maximum savings. Send for literature and prices to Tarrant Mfg. Co., 12 Maple Ave., Saratoga Springs, N. Y.

Sanders

270. Galion's new, inexpensive sander for quickly spreading sand, stone dust, cinders, chips, rock salt, calcium chloride, etc., is described and illustrated in a new circular which will be sent on request by Galion Iron Works & Mfg. Co., Galion, Ohio.

Street Cleaner's Can Carriers

290. "Street Sweepers' Friend," an improved roller bearing and rubber tired can carrier is described and illustrated in a new pamphlet which will be sent promptly on request by the Tarrant Manufacturing Co., Saratoga Springs, N. Y.

Street Markers

295. A new combination highway and street traffic marker and paint sprayer in an 8-page folder issued by Meili-Blumberg Corp., New Holstein, Wis. It is rugged, speedy, easy to operate, stripes straight or curved lines perfectly. Before buying a traffic marker be sure to send for this folder.

Snow Fighting

Plows

349. "Frink V Type Sno-Plows" is a 24 page catalog fully illustrating and describing 8 models of V Type Sno-Plows for motor trucks from 1½ up to 10 tons capacity, 16 models of Frink Leveling Wings, the Frink Hand Hydraulic Control and the latest Frink Selective Power Hydraulic Control. Data are given for selecting the proper size V plow and wing for any truck. Issued by Carl H. Frink, Mfr., Clayton, 1000 Islands. N. Y.

350. "Frink One-Way Sno-Plows" is a four page catalog illustrating and describing 5 models of One-Way Blade Type Sno-Plows for motor trucks from 1½ up to 8 tons capacity. Interchangeable with V Sno-Plow. Features, specifications and method of attaching. Carl H. Frink, Mfr., Clayton, 1000 Islands, N. Y.

HOW TO ORDER: These booklets are FREE. Write to the firm whose name is given, mentioning PUBLIC WORKS, or to this magazine.

Harlow Hardinge, new president of Hardinge Co., York, Pa., who succeeds H. W. Hardinge, now chairman of the Board.

American Road Builders' Ass'n.

George F. Schlesinger, engineer-director, National Paving Brick Association, Washington, D. C., was elected treasurer of the American Road Builders' Association at the convention and exhibit in San Francisco, Cal. He was also re-elected secretary-treasurer of the Manufacturers' Division of the organization. Officers re-elected for the coming year include Michigan State Highway Commissioner Murray D. Van Wagoner of Lansing, president; Paul B. Reinhold, secretary-treasurer, Reinhold and Co., Inc., Pittsburgh, Pa., vice-president, northeastern district; E. D. Kenna, director, Mississippi State Highway Department at Jackson, vice-president, southern district; Lion Gardiner, vice-president, Jaeger Machine Co., Columbus, Ohio, vice-president, central district, and Stanley Abel, supervisor, fourth district, Kern County, Taft, Cal., vice-president, western district. Directors elected for the term ending in 1942 were W. A. Van Duzer, director of vehicles and traffic, Washington, D. C.; Victor J. Brown, publishing director, Roads and Streets Magazine, Chicago, Ill.; Otto S. Hess, engineer-manager, Kent County Road Commission, Grand Rapids, Mich.; C. E. Myers, consulting engineer, Philadelphia, Pa.; Carl O. Wold, vice-president, Caterpillar Tractor Co., Peoria, Ill.; W. A. Young, Cornell-Young Co., Macon, Ga., and T. H. Cutler, chief engineer, department of highways, Frankfort, Ky.

Quincy A. Campbell, assistant chief engineer of the National Paving Brick Association, Washington, D. C., died at Cleveland, Ohio, April 19. Mr. Campbell was graduated from the Ohio State University in 1920 with the degree of Bachelor of Civil Engineering. He served in the army during the war, and was in engineering work in Ohio previous to joining the Brick Association eleven years ago.

Readers' Service Department

Sanitary Engineering

Anaylsis of Water

360. "Methods of Analyzing Water for Municipal and Industrial Use," is an excellent 94 page booklet with many useful tables and formulas. Sent on request by Solvay Sales Corp., 40 Rector St., New York, N. Y.

Activation and Aeration

375. This concise folder No. 1294 describes "Straightline Aerators" for activated sludge treatment; combines these features: 1, rapid circulation in the tanks; 2, exposure of large surfaces, hastened oxidation and bacteriological growth. Link-Belt Co., 2045 W. Hunting Park Ave., Philadelphia, Pa.

380. A valuable booklet on porous diffuser plates and tubes for sewage treatment plants. Covers permeability, porosity, pore size and pressure loss data, with curves. Also information on installations, with sketches and pictures, specifications, methods of cleaning and studies in permeability. 20pp. illustrated. Sent on request to Norton Company, Worcester, Mass.

Aerators for Sewage

381. New 24 page booklet, No. 6571 describes and illustrates the Dorrco Paddle Aerator and also the Turbo-Aerator. Also contains a discussion of the activated sludge method of treatment with much interesting data and illustrations, including a section of "Useful Information." Issued by The Dorr Co., 570 Lexington Ave., New York, N. Y.

Cast Iron Sewers

384. Cast Iron Pipe for Sewers. Cast Iron Pipe has beam strength, resistance to crushing stresses and infiltration-proof joints making it highly desirable for flow lines, force mains, submarine lines, outfalls and sewage treatment plants. For specifications write U. S. Pipe and Foundry Company, Burlington, N. J.

Chemical Treatment

385. A handbook on the application of chlorine and iron salts in sewerage treatment. Tech. Publication 177. Wallace & Tiernan Co., Inc., Newark, N. J.

Diesel Engines

386. Write Dept. 118, Fairbanks, Morse & Co., 600 So. Michigan Ave., Chicago, Ill., for data on how the installation of F-M diesels has lowered taxes and made it possible for many communitines to pay for their improvements out of municipal power plant earnings.

Feeders, Chlorine, Amonia and Chemical

387. For chlorinating water supplies, sewage plants, swimming pools and feeding practically any chemical used in sanitation treatment of water and sewage. Flow of water controls dosage of chemical; reagent feed is immediately adjustable. Starts and stops automatically. Literature from % Proportioneers, Inc.% 96 Codding St., Providence, R. I.

388. Chemical Feed Machines. Description, principles of operation; data on installation. E. W. Bacharach & Co., Rialto Building, Kansas City, Mo.

Filter Plant Controllers

389. "The Modern Filter Plant" and the uses of Simplex Controllers for operation are described in a handy, 16-page booklet. Charts, data, curves and tables. Simplex Valve and Meter Co., 68th and Upland Sts., Philadelphia, Pa.

Flow Meters

391. The primary devices for flow measurement—the orifice, the pilot tube, the venturi meter and others—and the application to them of the Simplex meter are described in a useful 24-page booklet (42A). Simplex Valve and Meter Co., 68th and Upland Sts., Philadelphia, Pa.

Garbage Incineration

392. Send for full information about

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Readers' Service Department

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the Decarie Suspended Basket-Grate Garbage Incinerator which solves the garbage disposal problem of any city economically and with a minimum of space. Nichols Engineering and Research Corp., 60 Wall Tower, New York, N. Y.

Manhole Covers and Inlets

404. Street, sewer and water castings made of wear-resisting chilled iron in various styles, sizes and weights. Manhole covers, water meter covers, adjustable curb inlets, gutter, crossing plates, valve and lamphole covers, ventilators, etc. Described in catalog issued by South Bend Foundry Co., South Bend, Ind.

Pipe, 2-inch Cast Iron

407. The new McWane 2" cast iron pipe in 18-foot lengths has innumerable uses in water and sewage work. Send for the new McWane bulletin describing this pipe, the various joints used, and other details about it. McWane Cast Iron Pipe Co., Birmingham, Ala.

Pipe, Concrete

409. Two excellent booklets, 12 and 16 pps., describe manufacture and installation of reinforced concrete pipe for gravity and pressure lines for sewage and storm drainage. Lock Joint Pipe Co., Ampere, N. J.

Pipe Forms

411. Making concrete pipe on the job to give employment at home is the subject of a new booklet just issued by Quinn Wire and Iron Works, 1621 Twelfth St., Boone, Ia., manufacturers of "Heavy Duty" Pipe Forms. Sent promptly on request.

Pipe Joints, Sewer

415. How to make a perfect sewer pipe joint—tight, prevents roots entering sewer, keeps lengths perfectly aligned; can be laid with water in trench or pipe. General instructions issued by L. A. Weston, Adams, Mass.

416. For full details of Servitite plastic sewer pipe joint compound which it is declared will positively prevent root growth, write Servicised Products Corp., 6046 West 65th St., Chicago, Ill.

Pumps and Well Water Systems

420. Installation views and sectional scenes on Layne Vertical Centrifugal and Vertical Turbine Pumps fully illustrated and including useful engineering data section. Layne Shutter Screens for Gravel Wall Wells. Write for descriptive booklets. Layne & Bowler, Inc., Dept. W, General Office, Memphis, Tenn.

Pumping Engines

424. "When Power Is Down," gives recommendations of models for standby services for all power requirements. Sterling Engine Company, Buffalo, N. Y.

Screens, Sewage

428. Be assured of uninterrupted, constant automatic removal of screenings. Folder 1587 tells how. Gives some of the outstanding advantages of "Straightline Bar Screens" (Vertical and Inclined types). Link-Belt Co., 307 N. Michigan Avenue, Chicago Ill.

Sewers

429. "ARMCO Sewers" is the title of a 48-page booklet describing the structural and other advantages of ARMCO Ingot Iron, Paved Invert and Asbestos-Bonded pipe for storm and sanitary sewers. Design data and large charts will be found helpful by engineers engaged in the design or construction of sewers. Copies will be sent on request by the Armco Culvert Mfrs. Association, Middletown, Ohio, or its associated member companies.

Meter Setting and Testing

430. All about setting and testing equipment for Water Meters—a beautifully printed and illustrated 40 page booklet giving full details concerning Ford setting and testing apparatus for all climates. Ford Meter Box Co. Wabash, Ind.

Rainfall Measurement

432. The measurement of precipitation, exposure of gauges, description of apparatus for measuring rainfall, both rates and amounts. Standard recorders for rain, snow and water level. Julien P. Friez & Sons, Baltimore, Md.

Traffic Engineering Fellowships

The Bureau for Street Traffic Research announces the availability, beginning September 26, 1939, of nineteen graduate fellowships. These have been made possible through a grant from the Automotive Safety Foundation and from Alfred P. Sloan, Jr.

Fellowships will be offered in two groups. The *Alfred P. Sloan State Highway Traffic Engineering Fellowship*, of which there are seven, are available only to employees of State Highway Departments. The *Bureau for Street Traffic Research Traffic Engineering Fellowships*, of which there are twelve, are available to employees of organizations having authority, responsibility, or function of traffic control and to graduate students seking a career in traffic engineering.

The fellowships provide a living stipend of $800.00, disbursed at the rate of $100.00 per month for eight months and a tuition fee of $400.00. In addition, special funds are available for scheduled field investigation while in attendance up to a maximum of $200.00. The total value of each of these fellowships is, therefore, approximately $1,400.00

These fellowships may be applied for by persons having the following qualifications:

I. *Bureau Fellowships:* (a) Applicants must be not more than thirty-five nor less than twenty-three years of age at the time of application; (b) applicants must have an engineering degree representing four years' work in an accredited college or university. (c) Preference will be given to men who have had: From one to five years of practical experience in a public engineering or administrative organization where they engaged personally in some phase of Traffic Engineering; exceptional grades during their college courses; in addition to their engineering course, courses in Planning, Government, Public Administration, Economics, Public Speaking, Psychology, Sociology, Philosophy, Physiology, Mathematics, and Statistics.

II. *Sloan Fellowships:* In addition to the general requirements for Bureau Fellowships, applicants for the Sloan fellowships must be directly employed at the time of application, on a full time permanent basis by a State Highway Department in some division whose operations are directly concerned with traffic control. Preference will be given to men having the preferential qualifications listed above in item "C."

Those desiring to make application for these Traffic Engineering fellowships must apply to Maxwell Halsey, Associate Director of the Bureau for Street Traffic Research, Room 315, Strathcona Hall, Yale University, New Haven, Connecticut for *Application Forms*. These will be sent by return mail. Application forms completely filled out and complied with must be returned with their enclosures to the Bureau offices not later than June 1, 1939, though earlier filing will be appreciated.

Readers' Service Department

Small Septic Tanks

438. Septic Disposal Systems, Waterless Toilets, Multiple Toilets for Camps and Resorts, and other products for providing safer sewage disposal for unsewered areas are described and illustrated in data sheets issued by San-Equip Inc., 700 Brighton Ave., Syracuse, N. Y.

Sludge Drying and Incineration

439. The five basic steps of: sludge preparation; flash drying; incineration; deodorization; and dust collection are explained in a new 24 page booklet, No. 6781 issued by The Dorr Company, 570 Lexington Ave., New York, N. Y., sales representatives for the C-E Raymond system of sludge drying and incineration.

440. Disposal of Municipal Refuse: Planning a disposal system; specifications. The production of refuse, weights, volume, characteristics. Fuel requirements for incineration. Also detailed outline of factors involved in preparation of plans and specifications. Morse-Boulger Destructor Co., 216P East 45th St., N. Y.

Swimming Pools

443. "Pure as the Water You Drink"—a well illustrated booklet of useful data for engineer and contractor, on how to make your swimming pool sanitary, hygienically safe and inviting. Write Graver Tank & Mfg. Co., Inc., 4956 Tod Ave., East Chicago, Ind.

444. A new booklet "Essential Factors in the Design and Layout of Swimming Pool Systems," with data on filtration equipment, fittings, solution feeders, accessories, etc., is available from Everson Manufacturing Co., 213 West Huron St., Chicago, Ill.

445. Data and complete information on swimming pool filters and recirculation plants; also on water filters and filtration equipment. For data, prices, plans, etc., write Roberts Filter Mfg. Co., 640 Columbia Ave., Darby, Pa.

447. "Painting Swimming Pools," an interesting booklet by Dr. A. F. Pistor, covers the subject thoroughly, discussing objectively the relative merits of the different types of coatings recommended for that purpose. Write Inertol Co., 401 Broadway, New York, N. Y.

Taste and Odor Control

448. How, when, and where activated carbon can and should be used to remove all kinds of tastes and odors from water supplies is told in a booklet issued by Industrial Chemical Sales Div., 230 Park Ave., New York, N. Y. 77 pages, tables, illustrations and usable data.

Treatment

450. "Safe Sanitation for a Nation," an interesting booklet containing thumbnail descriptions of the different pieces of P.F.T. equipment for sewage treatment. Includes photos of various installations and complete list of literature available from this company. Write Pacific Flush Tank Co., 4241 Ravenswood Ave., Chicago, Ill.

451. "Soft Water for Your Community," tells by means of many interesting pictures and text the advantages of soft water to any community. Ask for a copy from The Permutit Co., Dept. G4, 330 West 42nd St., New York, N. Y.

454. New 16-page illustrated catalog No. 1742 on Straightline Collectors for the efficient, continuous removal of sludge from rectangular tanks at sewage and water plants. Contains layout drawings, installation pictures, and capacity tables. Address Link-Belt Co., 2045 West Hunting Park Ave., Philadelphia, Pa.

Water Works Operating Practices

490. "Important Factors in Coagulation" is an excellent review with bibliography and outlines of latest work done in the field. Written by Burton W. Graham and sent free on request to Activated Alum Corp., Curtis Bay, Baltimore, Md.

HOW TO ORDER

To obtain any of these booklets without obligation, send a post card to the firm whose name and address are given in the description and MENTION PUBLIC WORKS MAGAZINE. Or, if you prefer, send your request to Readers' Service Dept., PUBLIC WORKS, 304 East 45th St., New York, N. Y.

For the Engineer's Library

Brief reviews of the latest books, booklets and catalogs for the public works engineer.

Pipe Corrosion:

Soil Corrosion and Pipe Line Protection. By Scott Ewing. 266 pp., with tables, charts and maps. $2.50 from American Gas Co., 420 Lexington Ave., N. Y. Technical information on causes and prevention. Includes survey and test methods, performance of protective coatings.

Earthquakes:

All about earthquakes in our western states, 1769 to 1928. Intensity of the shock, date, time and duration, area affected, loss of life and extent of property damage. The exact title of this 300-page book by S. D. Townley and M. W. Allen is "Descriptive Catalog of Earthquakes of the Pacific Coast of the United States." $2 per copy from Perry Byerly, Beacon Hall, University of California, Berkeley, Calif.

Public Works:

The Management of Municipal Public Works is a new book by Donald Stone. 344 pp. $3.75. Covers: Management Essentials, Personnel Administration, Standards and Measurements, Planning and Budgeting, Accounting, Purchasing, Administration and Maintenance and Construction. There are appendices and lists of forms. For sale by Public Administration Service, 1313 East 60th St., Chicago, Ill.

Water & Sewage Treatment:

Jeffrey equipment for water and sewage treatment plants includes self-cleaning sewage bar screens, with or without screenings grinders; grit washers; sludge collectors for primary and secondary tanks; scum removers; sludge elevators and chemical feeders. These are described in an excellent 16-page booklet. Jeffrey Mfg. Co., Columbus, O.

Little Rock Water Supply:

This booklet describes in detail the methods employed in constructing 32 miles of 39-inch Lock Joint reinforced concrete pressure pipe, together with the dam, spillway and other appurtenances required to furnish Little Rock, Ark., with a new supply of soft water. Someone has done a fine job in preparing and arranging this material. Sent on request to Lock Joint Pipe Co., Ampere, N. J.

Malaria:

Graphic reproduction of the life cycle of the malaria parasite in the mosquito host. 15 pp. 26 plates. By Bruce Mayne. Published by National Institute of Health. Reprints available from U. S. Public Health Service, Washington, D. C. No charge.

Index to ADVERTISEMENTS